Supreme Court, U.S.
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88-613
No.

IN THE

Supreme Court of the United States

OCTOBER TERM, 1988

E. I. DU PONT DE NEMOURS & COMPANY,
Petitioner,

v.

PHILLIPS PETROLEUM COMPANY, PHILLIPS 66 COMPANY, and PHILLIPS DRISCOPIPE, INC.,
Respondents.

APPENDIX TO PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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Opinion of the Court of Appeals,
June 15, 1988

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

87-1259 AND 87-1284

E. I. DU PONT DE NEMOURS & COMPANY,
Plaintiff-Appellant,

v.

PHILLIPS PETROLEUM COMPANY, PHILLIPS 66 COMPANY, AND PHILLIPS DRISCOPIPE, INC.,
Defendants-Cross-Appellants.

John O. Tramontine, Fish & Neave, of New York, New York, argued for plaintiff-appellant. With him on the brief were Edward F. Mullowney, Glenn A. Ousterhout and Thomas J. Vetter.

Philip S. Beck, Kirkland & Ellis, of Chicago, Illinois, argued for defendants-cross-appellants. With him on the brief were Harry J. Roper and George S. Bosy, Neuman, Williams, Anderson and Olson, of Chicago, Illinois.

Appealed from: U.S. District Court for the District of Delaware

JUDGE LATCHUM

Court of Appeals Opinion

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

87-1259 and 87-1284

E. I. DU PONT DE NEMOURS & COMPANY,
Plaintiff-Appellant,

v.

PHILLIPS PETROLEUM COMPANY, PHILLIPS 66 COMPANY, AND PHILLIPS DRISCOPIPE, INC.,
Defendants-Cross-Appellants.

DECIDED: June 15, 1988

Before BISSELL, *Circuit Judge,* and MILLER, *Senior Circuit Judge.**

BISSELL, *Circuit Judge.*

E. I. du Pont de Nemours & Company ("Du Pont") appeals from a judgment of the United States District Court for the District of Delaware, *see E. I. du Pont de Nemours & Co. v. Phillips Petroleum Co.,* 656 F. Supp. 1343, 2 USPQ2d 1545 (1987), that Du Pont failed to prove that the infringement of claims 1, 2, 5, 10, 12 and 14 of its U.S. Patent No. 4,076,698 ('698) was willful. Phillips Petroleum Company, Phillips 66 Company, and Phillips Driscopipe, Inc. (collectively, "Phillips"), the alleged infringers, cross-appeal from the district court's judgment that Du Pont proved infringement and that Phillips failed to prove invalidity under 35 U.S.C.

* Circuit Judge Archer heard oral argument in these appeals but subsequently recused himself, taking no position in the decision of this case.

§§ 102(g), 103 (1982 & Supp. III 1985), and unenforceability due to inequitable conduct. We affirm in part, reverse in part, vacate in part, and remand for further proceedings consistent with this opinion.

BACKGROUND

Polymers are large molecules formed when a smaller molecule, known as a monomer, joins chemically to itself in a repeating fashion. Forming a copolymer[1] involves joining different monomers. In Du Pont's invention, ethylene, a monomer, is copolymerized with a "higher alpha-olefin." This is a hydrocarbon having between 5 and 18 carbon atoms with a single double bond at one end.[2]

The copolymers of the six claims at issue are in part defined by their properties. Consider, for example, claim 5:

> 5. An interpolymer of ethylene and a higher olefinic hydrocarbon having 5 to 10 carbon atoms per molecule, said higher olefinic hydrocarbon having one terminal -CH=CH_2 per molecule and no other olefinic unsaturation, said interpolymer being further characterized in that it has an X-ray crystallinity in the range of 40 to 70%, a melt index in the range of 0.3 to 20, a density in the range of 0.9 to 0.95 and said interpolymer being further characterized in that its density is not less than 0.93 unless the content of said higher olefinic hydrocarbon in the interpolymer is at least 3% by weight.

The remaining claims are similar, though claim 1 requires a certain "Elmendorf tear strength," and claim 12 requires a specified hoop stress. All six claims are reproduced in the Appendix below.

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[1] *i.e.*, "interpolymer."

[2] In comparison, a "lower alpha-olefin" would have 3-4 carbon atoms.

Du Pont filed its original patent application on March 1, 1956, and a continuation-in-part (CIP) application, S.N. 632,416, on January 4, 1957. The '698 patent issued from the CIP application on February 28, 1978, to Anderson and Stamatoff. The delay in issuance was partially due to an interference proceeding before the Board of Patent Interferences at the United States Patent & Trademark Office (PTO). As originally filed, the application contained both product and process claims. However, the process claims were cancelled following the interference proceeding, leaving 15 product claims in the '698 patent.

In 1981, Du Pont filed the infringement suit now on appeal. Phillips in its Answer and Counterclaim alleged invalidity, unenforceability, and noninfringement. In a bifurcated trial, the court tried the liability issues from July 21, 1986 through August 18, 1986. During the district court proceedings, the PTO conducted a merged reissue/reexamination proceeding of the '698 patent that culminated, on May 12, 1986, with a final rejection of all the claims. On June 11, 1986, Du Pont appealed that rejection to the PTO Board of Patent Appeals and Interferences but that appeal was stayed as of August 6, 1986.

Included in the prior art Phillips relied on at trial were the three items relied on in the appeal: (1) the 1955 work of Witt and Leatherman—researchers for Phillips; (2) Vandenberg U.S. Patent No. 3,058,963; and (3) Brown U.S. Patent No. 2,728,752.

At trial, Du Pont conceded that Phillips, through the work of Witt and Leatherman, made ethylene/higher alpha-olefin copolymers in the United States before the date of the claimed invention. However, Du Pont claimed that its copolymers could be distinguished from those of

Phillips because of two properties disclosed in its patent specification but not expressly written into the claims. The district court accepted Du Pont's argument, incorporated those two properties as limitations into the six claims at issue, and determined that the claims were not invalid, not unenforceable, and infringed but not willfully.

ISSUES

1. Whether the district court erred in incorporating two extraneous property limitations into the claims.

2. Whether the district court erred in holding that the claims were not invalid under 35 U.S.C. § 102(g).

3. Whether the district court erred in holding that the claims were not invalid under 35 U.S.C. § 103.

4. Whether the district court erred in holding that the patent was not unenforceable.

5. Whether the district court clearly erred in finding that the claims were infringed.

6. Whether the district court applied the incorrect standard of proof regarding willful infringement.

OPINION

I. VALIDITY

A. Claim Interpretation

The district court believed that the essence of Du Pont's invention is that its copolymers, when compared with "free-radical polyethylene, with linear polyethylene and with comparable copolymers of ethylene . . . and the

lower alpha-olefins," possess superior (1) environmental stress crack resistance and (2) impact strength. *Du Pont,* 656 F. Supp. at 1350, 2 USPQ2d at 1547. The district court interpreted the claims as including those two properties. In doing so, it erred.

The significance of claims in defining an invention was clearly expressed by our predecessor court in *Autogiro Co. of America v. United States,* 384 F.2d 391, 395-96, 155 USPQ 697, 701 (Ct. Cl. 1967):

> The claims of the patent provide the concise formal definition of the invention. They are the numbered paragraphs which 'particularly [point] out and distinctly [claim] the subject matter which the applicant regards as his invention.' 35 U.S.C. § 112. It is to these wordings that one must look to determine whether there has been infringement. [Footnote omitted.] Courts can neither broaden nor narrow the claims to give the patentee something different than what he has set forth. [Footnote omitted.] No matter how great the temptations of fairness or policy making, courts do not rework claims. They only interpret them.

In accordance with that instruction, this court has consistently adhered to the proposition that courts "cannot alter what the patentee has chosen to claim as his invention." *SSIH Equipment S.A. v. U.S. Int'l Trade Comm,* 718 F.2d 365, 378, 218 USPQ 678, 689 (Fed. Cir. 1983) (citing *Autogiro*); *see also Loctite Corp. v. Ultraseal Ltd.,* 781 F.2d 861, 867, 228 USPQ 90, 93 (Fed. Cir. 1985) ("Generally, particular limitations or embodiments appearing in the specification will not be read into the claims."). Indeed, neither Du Pont nor the district court cites any case of this court reading extraneous limitations into a claim.

It is entirely proper to use the specification to interpret what the patentee meant by a word or phrase in the claim. *See, e.g., Loctite Corp. v. Ultraseal Ltd.,* 781 F.2d 861, 867, 228 USPQ 90, 93 (Fed. Cir. 1985). But this is not to be confused with adding an extraneous limitation appearing in the specification, which is improper. By "extraneous," we mean a limitation read into a claim from the specification wholly apart from any need to interpret what the patentee meant by particular words or phrases in the claim. "Where a specification does not *require* a limitation, that limitation should not be read from the specification into the claims." *Specialty Composites v. Cabot Corp.,* Nos. 87-1456, -1457, slip op. at 11 (Fed. Cir. April 27, 1988 (emphasis in original), citing *Lemelson v. United States,* 752 F.2d 1538, 1551-52, 224 USPQ 526, 534 (Fed. Cir. 1985).

Although the district court cited as support *United States v. Adams,* 383 U.S. 39, 148 USPQ 479 (1966), *Adams* does not support reading into the claims extraneous limitations from the specification. *Adams* involved claims to a battery comprising a combination of various claimed elements, none of which was water. Adams argued that the battery, unlike prior art batteries, could be successfully and unexpectedly operated with water. Though using water was not expressly included in the claims, that unexpected feature was relevant to the Court's decision on nonobviousness. *See, e.g., Graham v. John Deere,* 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966) (objective indicia are probative of nonobviousness).

It was not necessary for the Court in *Adams* to read, and the Court did not read, a "water" limitation into the claims. The Court discussed the water feature only when considering rebuttal of defendant's argument of obviousness. Properly interpreted, *Adams* does not deviate from

this language in a Supreme Court precedent that *Adams* refers to for authority:

> [W]e know of no principle of law which would authorize us to read into a claim an element which is not present, for the purpose of making out a case of novelty or infringement. The difficulty is that if we once begin to include elements not mentioned in the claim in order to limit such claim and avoid a defense or anticipation, we should never know where to stop.

McCarty v. Lehigh Valley R. Co., 160 U.S. 110, 116 (1895) (cited in *Adams*, 383 U.S. at 48-49, 148 USPQ at 482).

Du Pont contends that *Decca Limited v. United States*, 420 F.2d 1010, 164 USPQ 348 (Ct. Cl. 1970), *cert. denied*, 400 U.S. 865 (1970), supports the district court decision. It is mistaken. The claims at issue in *Decca* were written in "means plus function" format, which are subject to the last paragraph of 35 U.S.C. § 112. Hence, resort to the specification in *Decca* was necessary not only pursuant to the normal rule of resorting to the specification to interpret what the patentee meant by claim language, but also, pursuant to statute.

Although language in *Decca* and other Court of Cliams decisions may have given the perception that claims are to be "saved" from invalidity by reading extraneous limitations into them, *see, e.g., SSIH Equipment S.A. v. USITC*, 718 F.2d 365, 385, 218 USPQ 678, 695 (Fed. Cir. 1983) (Smith, J., concurring in part, dissenting in part), this court's consistent approach in interpreting claims, and in rejecting resort to extraneous limitations from the specification, should have negated that perception by now. *See Sjolund v. Musland, Norsol, Inc. and Wink Corp.*, No. 87-1496, slip op. at 23 (Fed.

Cir. June 1, 1988) ("limitations from the specification are not to be read into the claims"). Thus, the district court was wrong as a matter of law in reading into the claims at issue the two extraneous property limitations mentioned above. The remainder of this opinion, and the proceedings on remand below, shall treat the claims as not containing those limitations.

B. Novelty—35 U.S.C. § 102(g)

The novelty issue relates to 35 U.S.C. § 102(g), which states that a person is entitled to a patent unless "before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it."

The claims in this case fall into two groups. One group—claims 2, 5, 10 and 14—contains limitations pertaining only to density, percent crystallinity, melt indices, percent monomer, and type of monomer. Independent claim 5, reproduced above, is representative. Du Pont has conceded that the Witt and Leatherman copolymers of Phillips made in this country before the Du Pont invention, satisfied those limitations.[3] Because it is con-

[3] At trial, Du Pont conceded as follows:

DuPont judicially admits that before the date of DuPont's invention of the patent in suit, Gerald T. Leatherman and Donald R. Witt, researchers at Phillips, made in the United States copolymers of ethylene with propylene, ethylene with l-butene, ethylene with l-pentene and ethylene with l-hexene. That those ethylene with l-pentene copolymers had comonomer-type, density, melt index, percent crystallinity and weight percent comonomer content falling within the ranges expressly called for by the claims asserted against Phillips in this action.

That those ethylene-l-hexene copolymers had comonomer-type, density, percent crystallinity and weight percent comonomer content falling within the ranges expressly called for by the claims asserted against Phillips in this action and melt indices of 0.19 and 0.27.

DuPont will not attempt to prove in this action that the invention of the patent in suit was made by DuPont before the dates that those ethylene-l-pentene copolymers and ethylene-l-hexene copolymers were made by Gerald T. Leatherman and Donald R. Witt.

ceded that the copolymers of claims 2, 5, 10 and 14 are anticipated by the prior work of Phillips, we reverse the district court's determination with respect to these claims, and hold these claims invalid.

The second group of claims—claims 1 and 12—must be addressed on remand. Those two claims include a limitation not present in the other four claims and not conceded by Du Pont to be present in the Witt and Leatherman copolymers. Claim 1 includes this limitation: "when in the form of a film, an Elmendorf tear strength in the range of 150 to 400 grams per mil." Claim 12, which claims the copolymer in the form of pipe, recites a limitation to impact strength in terms of hoop stress. To find anticipation of claims 1 and 12, the district court must determine that Phillips met its burden of proving by clear and convincing evidence that the copolymers it made prior to Du Pont's invention possessed those properties. *See American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1360, 220 USPQ 763, 771 (Fed. Cir.), *cert. denied*, 469 U.S. 821 (1984).

Phillips asserts, citing *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985), that the strength limitations of claims 1 and 12 are merely property limitations that cannot serve to distinguish the claims from the Witt and Leatherman copolymers. In *Titanium*, the claims covered, for example, a "titanium based alloy consisting essentially by weight of about 0.6% to 0.9% nickel, 0.2% to 0.4% molybdenum, up to 0.2% maximum iron, balance titanium, said alloy being characterized by good corrosion resistance in hot brine environments." The reference upon which both the Patent

Office and the court based their § 102 rejections showed an alloy with those percentages, and the court stated:

> Congress has not seen fit to permit the patenting of an old alloy, known to others through a printed publication, by one who has discovered its corrosion resistance or other useful properties, or has found out to what extent one can modify the composition of the alloy without losing such properties.

Id., 778 F.2d at 782, 227 USPQ at 778.

Titanium, however, does not mean that property limitations can never have meaning in a claim. On occasion, particularly with polymers, structure alone may be inadequate to define the invention, making it appropriate to define the invention in part by property limitations. As the district court here recognized in assessing the issues under 35 U.S.C. § 112, "if the claims, read in light of the specification, reasonably apprise those skilled in the art both of the utilization and scope of the invention, and if the language is as precise as the subject matter permits, the courts can demand no more." *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1385, 231 USPQ 81, 94 (Fed. Cir. 1986), *cert. denied,* 107 S. Ct. 1606 (1987).[4]

Here, the district court found that "[t]he ethylene-higher alpha-olefin copolymers of the invention are characterized by several parameters so that they can be distinguished by external tests from linear ethylene homopolymers and from linear ethylene copolymers that are rubber-like." *Du Pont,* 656 F. Supp. at 1350, 2

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[4] *Compare Seattle Box, Inc. v. Industrial Crating & Packing, Inc.*, 731 F.2d 818, 826, 221 USPQ 568, 574 (Fed. Cir. 1984) (the test for adequacy under § 112 ¶ 2 is "whether one of ordinary skill in the art would understand what is claimed when the claim is read in light of the specification").

USPQ2d at 1547. The district court concluded that those parameters "are measurements of comonomer content, density, and percent crystallinity." *Id.* However, the district court implicitly used additional parameters to help define the claimed invention because it read into the claims the two property limitations discussed above in Part I, A, and considered the Elmendorf strength of claim 1 and hoop stress of claim 12 in determining validity and infringement.

Furthermore, Du Pont's expert, Dr. Beasley, testified that "if process parameters are not identical in two polymerizations intended to make ethylene copolymers using the same monomers, the resultant copolymer will probably have different properties." The district court accepted that and noted: "the court now assumes that Phillips is not urging the theory initially espoused by Dr. Price that compounds that have the same general chemical structure will have the same properties regardless of how they are made." Thus, the district court found the interpolymer actually produced depends in part on the process used to prepare it. *Du Pont,* 656 F. Supp. at 1365, 2 USPQ2d at 1560.

It is clear, therefore, that the district court correctly regarded the claimed interpolymers as compositions that can be permissibly defined in terms of structure and properties. Thus, the issue is not, as in *Titanium,* whether one can get a patent on discovering a new property of an old composition of matter. The issue is whether the claimed copolymer, as defined in part by various property parameters, is new. In *Titanium,* once the alloy disclosed in the prior art reference was determined to possess the structural limitations of the claim, the burden shifted to the applicants to show that the alloy disclosed in the

reference did not possess the claimed property. Here, however, Phillips has not shown that their interpolymers of ethylene and higher alpha olefins possess the property limitations set forth in the claims.

As the one challenging validity, Phillips must prove on remand that the strength limitations of claims 1 and 12 are possessed by the Witt and Leatherman products. *See Tyler Refrigeration v. Kysor Industrial Corp.*, 777 F.2d 687, 689, 227 USPQ 845, 846-47 (Fed. Cir. 1985) (identity of invention is question of fact and challenger must show that each element of claim is found in a prior patent or publication, either expressly or under principles of inherency). In meeting that burden, Phillips need not prove awareness by Witt and Leatherman that their products possessed the properties. Also, Phillips is entitled to rely not only on the Witt and Leatherman patent application and its corresponding foreign patent applications, but also on the notebook data presented by Phillips. The district court did not allow Phillips to use that data regarding the two improper claim limitations discussed above in Part I, A, because it determined that the data on stress crack resistance was "abandoned, suppressed, or concealed." Du Pont, 656 F. Supp. at 1355-56, 2 USPQ2d at 1551-52. That was legally incorrect if 35 U.S.C. § 102(g), as opposed to the Federal Rules of Evidence, was used as the basis of excluding the data. The inquiry under § 102(g) allows Phillips to use any relevant data to prove its defense unless the information is otherwise untimely produced.

C. Nonobviousness

As the district court recognized, determining nonobviousness is a legal question based on factual under-

pinnings. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 567 (1966); *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1566-68, 1 USPQ2d 1593, 1596-97 (Fed. Cir.), *cert. denied*, 107 S. Ct. 2187 (1987). Changing the definition of the claims used by the district court by eliminating the two limitations it improperly read into the claims may affect a number of those factual inquiries and the legal conclusion itself. Because of that, we deem it appropriate for the district court to reassess the nonobviousness of claims 1 and 12 as properly defined. We can review that legal assessment, in any subsequent appeal, for error or the underlying fact findings for clear error.

However, because the district court applied an incorrect test in excluding the work of Witt and Leatherman as prior art for § 103 purposes, we give guidance to the court on one aspect of one of the factual underpinnings of nonobviousness, the "scope and content of the prior art." *Id.* Specifically, we now address when § 102(g) prior work can be used as § 103 prior art.

The district court in excluding the work of Witt and Leatherman applied a test derived from *In re Clemens*, 622 F.2d 1029, 1039-40, 206 USPQ 289, 299 (CCPA 1980): the work of another under § 102(g) is prior art under § 103 only when that work is known to the art or to the patentee before he made the invention. *See, e.g., Kayton on Patents*, 5-28 (2d ed. 1983). Applying that test, the district court held that Phillips' prior work was not usable in a § 103 context "[b]ecause Phillips' work was kept secret and was unknown to both the du Pont

researchers and the art."[5] *Du Pont,* 656 F. Supp. at 1363, 2 USPQ2d at 1558. The district court also relied on *Kimberly-Clark Corp. v. Johnson & Johnson,* 745 F.2d 1437, 223 USPQ 603 (Fed. Cir. 1984), and Phillips contends that *Kimberly-Clark* eliminated the test of *Clemens.* We agree with Phillips.

Kimberly-Clark distinguished as dictum the *Clemens* requirement of applicant's personal knowledge because "§ 102(g) contains no personal knowledge requirement." 745 F.2d at 1445, 223 USPQ at 607. Nor does § 102(g) contain a "known to the art" requirement apart from the requirement of no abandonment, suppression or concealment. Hence, the alternative *Clemens* requirement that the prior work be "known to the art" is also implicitly dismissed as dictum. That implication is further supported by the conclusion in *Kimberly-Clark* that certain prior work at issue, solely because it satisfied § 102(g) (i.e., it was reduced to practice and had not been abandoned, suppressed or concealed), could be used for § 103 purposes. *Id.,* 745 F.2d at 1444, 223 USPQ at 606; *see also Hybritech Inc. v. Monoclonal Antibodies, Inc.,* 802 F.2d 1367, 1371 n.1, 231 USPQ 81, 84 n.1 (Fed. Cir. 1986) (§ 102(g) prior art can be used for § 103).

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[5] Because work is "secret" does not necessarily mean that it has been "abandoned, suppressed or concealed." The latter determination depends on the overall facts of each case. For example, the filing of a United States patent application, as Phillips did here, maintains the secrecy of work, but is a factor cutting against abandonment, suppression or concealment. In any event, Du Pont conceded that the prior Phillips work has not been abandoned, suppressed or concealed, e.g., it admits in its reply brief that the Witt and Leatherman work is "available as a defense of prior invention under Section 102(g)." In that regard, the Phillips' work was the subject of foreign patent applications, speeches at various conferences, and papers presented at American Chemical Society meetings.

The concurring opinion in *In re Bass,* 474 F.2d 1276, 177 USPQ 178 (CCPA 1973), properly characterized the proposition for which *Kimberly-Clark* stands by stating:

> [t]he term 'prior art' as it is used in 35 U.S.C. § 103 should include all inventions which were made in this country before an applicant or patentee made his invention, regardless of when those inventions are made public or patent applications on them are filed, so long as those inventions are found not to have been abandoned, suppressed, or concealed.

474 F.2d at 1292, 177 USPQ at 190. Moreover, although *Kimberly-Clark* concluded there was no abandonment, suppression, or concealment because of a filed patent application that issued, *Kimberly-Clark* does not *require* that a patent application be filed or a patent be issued before § 102(g) prior work can qualify as § 103 prior art.

Certainly the court in *Kimberly-Clark* was concerned about "secret prior art." 745 F.2d at 1446, 223 USPQ at 607. Nevertheless the requirement of proving no abandonment, suppression, or concealment does mollify somewhat the "secret" nature of § 102(g) prior art. Despite its concern over "secret prior art," the court in *Kimberly-Clark* allowed prior work to be used as prior art in a § 103 context so long as it satisfied the requirements of § 102(g). As stated in the concurring opinion in *Kimberly-Clark,* the majority opinion "has extended the scope of what constitutes the prior invention of another, under § 102(g), to encompass the prior work of another

which has been reduced to practice." 745 F.2d at 1460, 223 USPQ at 619 (footnote omitted).[6]

II. INFRINGEMENT

As indicated above, we reverse the district court's claim interpretation with respect to the two property limitations "read into" the claims and, with respect to the judgment that Phillips has not proven invalidity, we reverse for claims 2, 5, 10 and 14 and vacate for claims 1 and 12. Thus, the judgment of infringement must also be vacated. However, on the infringement issue it is appropriate for judicial economy to review Phillips' challenge to the district court's interpretation of the density and crystallinity parameters appearing in claims 1 and 12.

A. Density

Phillips urges that the "0.95" limitation appearing in the claims means "0.950" and that the district court incorrectly interpreted "0.95" as meaning between 0.9451 and 0.9550. Consequently, Phillips urges that the district court incorrectly found that Phillips' products, having a density between 0.9501 and 0.9550, literally infringed the claims at issue.

Phillips urges that during the prosecution history Du Pont made arguments on the meaning of the density that are contrary to the district court's interpretation. We agree with Phillips that arguments made during the

[6] The effect of using § 102(g) for § 103 purposes is limited by the Patent Law Amendments Act of 1984. Pursuant thereto, this sentence was added to 35 U.S.C. § 103: "Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person."

prosecution history are relevant in determining the meaning of the terms at issue. Those arguments, and other aspects of the prosecution history, as well as the specification and other claims, must be examined to ascertain the true meaning of what the inventor intended to convey in the claims. *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 867, 228 USPQ 90, 93-94 (1985). Using the prosecution history in that manner is different from prosecution history estoppel, which is applied as a limitation upon the doctrine of equivalents after the claims have been properly interpreted. *Id.*, 781 F.2d at 870, 228 USPQ at 96. The district court here incorrectly assumed that prosecution history can be used only in the latter regard. After noting that "Phillips advanced five prosecution history estoppel arguments related to the claim parameters of density, crystallinity and comonomer content in an effort to restrict the scope of the asserted claims," *Du Pont*, 656 F. Supp. at 1388, 2 USPQ2d at 1579, the court concluded that none of the arguments "involve the classic situation for estoppel, such as if Du Pont had narrowed a claim by amendment and now sought to require what was given up by resort to the doctrine of equivalents." *Id.*

In interpreting "0.95" the district court referred to the specification and to "customary scientific notations." *Id.* at 1385, 2 USPQ2d at 1577. However, during prosecution Du Pont argued that a density between 0.950 and 0.955 was not within the scope of its claims. This position is inconsistent with the claim interpretation Du Pont now urges. Specifically, the examiner rejected Du Pont's pending claims, stating in part: "Since the polymers disclosed by the [Field and Feller (F&F)] references have densities *within the scope* of applicants' claims . . . it is not seen how the instantly claimed copolymers differ

from those of the references." (Emphasis added.) In response, Du Pont argued:

> [W]herever given in Field and Feller, the densities of the 'normally solid hydrocarbon material' polymerization product, where some olefinic material, other than propylene, was included in the reaction mixture with ethylene, were in the range of linear polyethylene homopolymers (0.954 - 0.97) rather than in the range (0.9 to 0.95) of the novel branched polyethylenes (ethylene 1-olefin copolymers) claimed by applicants.

The examiner posited in the rejection that the F&F densities, including one of 0.9547, were within the scope of Du Pont's claims (0.9 to 0.95), but that was contested by Du Pont.

Du Pont argues that the examiner, in subsequently withdrawing his rejection, placed no reliance on the 0.95 density recitation to distinguish F&F. That misses the point. Regardless of the examiner's motives, arguments made during prosecution shed light on what the applicant meant by its various terms. Not only did Du Pont argue that an F&F density of 0.954 fell outside the scope of its claims but also, regarding the next highest F&F density, 0.9557, Du Pont stated that it was "far above" any densities of applicant's unique, branched polyethylenes. Du Pont also stated that the F&F density of 0.9585 had a "quite high density."

In light of that prosecution history, as well as other factors such as the patent specification, the district court should ascertain on remand the meaning of the density parameter. If the court determines that the parameter has changed, it should reassess infringement. We caution, however, that even if the district court decides in light of

the prosecution history to redefine the density as 0.950, and accordingly, changes its finding of literal infringement for those products of Phillips having a density between 0.9501 and 0.9550, the issue of infringement under the doctrine of equivalents must be addressed by the court. As indicated in *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 871, 228 USPQ 90, 96 (Fed. Cir. 1985), merely because certain prosecution history is used to define the claims more narrowly, there still *may* be—even in light of that same prosecution history—an appropriate range of equivalents under the doctrine of equivalents.

B. Crystallinity

On crystallinity, Phillips urges that the 70% maximum limitation means "70%," not "70% ± a variance of 10%-20%" as interpreted by the district court. As with density, the district court seemed to find prosecution history relevant only in an estoppel context. That, again, is incorrect. With Phillips' interpretation, products over 70% would not literally infringe; with the district court's interpretation, some were held to infringe literally.

The district court seemed to ignore arguments made during the reissue/reexamination proceeding that prior art polymers including those with crystallinity of 38%, 32%, and 38% were "outside the scope of appellant's claims." Statements made during reissue are relevant prosecution history when interpreting claims. *See, e.g., Howes v. Medical Components*, 814 F.2d 638, 645, 2 USPQ2d 1271, 1275 (Fed. Cir. 1987); *Standard Oil Co. v. American Cyanamid Co.*, 774 F.2d 448, 452, 227 USPQ 293, 296 (Fed. Cir. 1985).

It is relevant to the claim interpretation here that Du Pont urged that something 2% off the claimed lower limit

of 40% is not in the range, yet later argued for a variance of 10%-20% off the upper limit. As with density, therefore, we instruct the district court judge on remand to reassess the meaning of the crystallinity parameter. Again as with density, however, even if the district court redefines the parameter as "70% without variance," the issue of infringement under the doctrine of equivalents must still be addressed.

C. Remand Instructions

On remand, the district court should ascertain the meaning of a density of "0.95" and a crystallinity of "70%." If it means "0.950" density or "70% without variance" crystallinity, infringement will have to be reassessed under the doctrine of equivalents for those Phillips products having a density over 0.950 or a crystallinity over 70%. However, the instruction to reassess the definitions of "0.95" and "70%" does not affect the infringement determination unchallenged on appeal for those infringing Phillips products that have a density below 0.950 and a crystallinity less than 70%.

III. INEQUITABLE CONDUCT

Phillips alleges as inequitable conduct (1) Du Pont's failure to inform the PTO about the alleged status of Du Pont's Rule 131 affidavit, and (2) Du Pont's improper selection of data. The district court rejected those arguments apparently because it found that Phillips failed to prove by clear and convincing evidence that the alleged misrepresentations were material. Phillips has not shown us that those findings were clearly erroneous, *J.P. Stevens & Co. v. Lex Tex Ltd.*, 747 F.2d 1553, 1562, 223 USPQ 1089, 1094 (Fed. Cir. 1984), *cert. denied*, 474 U.S. 822 (1985), nor that the conclusions of no inequitable conduct

were otherwise incorrect. In reaching that conclusion in the context of this case, we are reminded of this admonition of *Kimberly-Clark v. Johnson & Johnson,* 745 F.2d 1437, 1454, 223 USPQ 603, 614 (Fed. Cir. 1984): "Fraud in the PTO' has been overplayed, is appearing in nearly every patent suit, and is cluttering up the patent system."

IV. WILLFULNESS

The district court decided that Du Pont did not prove willfulness by clear and convincing evidence, although it stated that Du Pont would have proven infringement if the standard of proof had been a preponderance of the evidence. Du Pont argues on appeal that willful infringement need only be proved by a preponderance of the evidence. *Du Pont,* 656 F. Supp. at 1394, 2 USPQ2d at 1584. That is legally incorrect. As this court stated in *Shatterproof Glass Corp. v. Libbey-Owens Ford Co.,* 758 F.2d 613, 628, 225 USPQ 634, 644 (Fed. Cir. 1985): "[t]he jurisprudence . . . uniformly requires clear and convincing evidence in support of increased damages."

Du Pont cites *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.,* 806 F.2d 1565, 1569, 1583, 1 USPQ2d 1081, 1083, 1094 (Fed. Cir. 1986). There the court did not specifically focus on the proper standard to apply, but, when discussing the procedural history at the district court it stated generally that the "54 jointly prepared questions . . . [submitted to the jury] . . . recognized the appropriate burdens to be met by each of the parties as well as the corresponding standard of proof with respect to each issue." *Id.* at 1569, 1 USPQ2d at 1083. One of the standards, not discussed in the opinion, is revealed by question 24, contained in the APPENDIX to the opinion: "Do you find that Orthokinetics has proved by a pre-

ponderance of the evidence that the infringement of the ['867] patent by any of the following defendants was willful?"

Obliquely, therefore, *Orthokinetics* might support Du Pont's position. However, *Orthokinetics* never focused on the issue, and we conclude that *Orthokinetics* never intended to change the proper test stated in *Shatterproof*.

DECISION

In view of the foregoing: (1) the district court's claim interpretation is (a) reversed insofar as it has "read into" the claim two extraneous property limitations, and (b) vacated insofar as it has interpreted a density limitation of "0.95" to mean "0.9451-0.9550" and a crystallinity limitation of "70%" to mean "70% ± 10-20%"; (2) the district court's judgment that Phillips did not prove invalidity under 35 U.S.C. § 102(g) is reversed for claims 2, 5, 10, and 14 and vacated for claims 1 and 12; (3) the district court's judgment that Phillips did not prove invalidity under 35 U.S.C. § 103 is vacated for all claims; (4) the district court's judgment that Phillips did not prove unenforceability is affirmed; (5) the district court's judgment that Du Pont proved infringement is vacated; and (6) the district court's judgment that Du Pont did not prove willful infringement is affirmed. This case is remanded for further proceedings consistent with this opinion.

COSTS

Costs are awarded to Phillips.

AFFIRMED IN PART, REVERSED IN PART, VACATED IN PART AND REMANDED

APPENDIX

1. An interpolymer composed of interpolymerized comonomers consisting essentially of ethylene and at least one normal aliphatic mono-alpha-olefinic hydrocarbon containing from 5 to 10 carbon atoms per molecule, the proportion of said monoolefinic hydrocarbon being from 3 to 7% of the weight of the interpolymer, said interpolymer having a melt index within the range of 0.3 to 20, and, when in the form of a film, an Elmendorf tear strength in the range of 150 to 400 grams per mil, and a density of 0.93 to 0.94.

2. An interpolymer of ethylene and from 1% to 20% by weight of a higher olefinic hydrocarbon having 5 to 18 carbon atoms per molecule, said higher olefinic hydrocarbon having no non-aromatic unsaturation other than one terminal $-CH=CH_2$ per molecule, said interpolymer having essentially no other copolymerized components, the proportion of the interpolymerized ethylene component therein being not less than 80% nor more than 99% by weight, the percentage crystallinity of the interpolymer being such that the density ranges from 0.95 at 1% interpolymerized higher olefinic hydrocarbon down to 0.9 at 20% interpolymerized higher olefinic hydrocarbon.

5. An interpolymer of ethylene and a higher olefinic hydrocarbon having 5 to 10 carbon atoms per molecule, said higher olefinic hydrocarbon having one terminal $-CH=CH_2$ per molecule and no other olefinic unsaturation, said interpolymer being further characterized in that it has an X-ray crystallinity in the range of 40 to 70%, a melt index in the range of 0.3 to 20, a density in the range of 0.9 to 0.95 and said interpolymer being further characterized in that its density is not less than 0.93 unless the

content of said higher olefinic hydrocarbon in the interpolymer is at least 3% by weight.

10. Composition of claim 5 in the form of a film.

12. Composition of claim 5 in the form of pipe which is further characterized by withstanding 3000 hours at hoop stress of 750 psi and a temperature of 60°C.

14. A composition of claim 5 having a density in the range of 0.910 to 0.945 and a melt index in the range of 0.3 to 2.1.

Opinion of the District Court After Trial, February 26, 1987

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

Civil Action No. 81-508-JLL

E.I. DU PONT DE NEMOURS & COMPANY,

Plaintiff,

v.

PHILLIPS PETROLEUM COMPANY, PHILLIPS 66 COMPANY, and PHILLIPS DRISCOPIPE, INC.,

Defendants.

William O. LaMotte III of Morris, Nichols, Arsht & Tunnell, Wilmington, Del., and John O. Tramontine, Edward F. Mullowney, Glenn A. Ousterhout, and Thomas J. Vetter of Fish & Neave, New York, N.Y., for plaintiff.

C. Waggaman Berl, Jr., Wilmington, Del., and Harry J. Roper, Sidney Neuman, George S. Bosy, Nicholas A. Poulos, Lawrence E. Apolzon, Susan Bennett Fentress, Raymond N. Nimrod, and Steven R. Trybus of Neuman, Williams, Anderson & Olson, Chicago, Ill., for defendants.

District Court Opinion

OPINION

Wilmington, Delaware
February 26, 1987

LATCHUM, Senior Judge.

I. INTRODUCTION

This is a patent infringement suit[1] in which the plaintiff, E.I. duPont de Nemours and Company ("DuPont"), has charged the defendants, Phillips Petroleum Company, Phillips Chemical Company, whose name was changed during the pendency of this case to Phillips 66 Company, and Phillips Driscopipe, Inc., with the infringement of Claims 1, 2, 5, 10, 12, and 14 of DuPont's U.S. Patent No. 4,076,698 ("the '698 patent"). (Docket Item ["D.I."] 212 at 1.) Since Phillips Chemical Company, now named Phillips 66 Company, and Phillips Driscopipe, Inc., are wholly owned Delaware corporate subsidiaries of Phillips Petroleum Company, all three defendants will be referred to collectively as "Phillips." (D.I. 212 at 1 and 252.) Phillips' Answer, Affirmative Defenses, and Counterclaims allege that the '698 patent is invalid and unenforceable for various reasons and there has been no infringement. (D.I. 159.) In addition, Phillips filed a pretrial motion for summary judgment to dismiss DuPont's suit under the doctrine of collateral estoppel based on a rejection of all the claims of the '698 patent by a Patent Examiner entered in a reissue-reexamination proceeding in the Patent Office. (D.I. 210.) The Court reserved decision on the summary judg-

[1] Subject matter jurisdiction exists by virtue of 28 U.S.C. § 1338(a). Personal jurisdiction and venue are not disputed by the parties. (D.I. 212 at 2.)

ment motion until after trial. The parties stipulated with Court approval that the liability issues of validity, enforceability, and infringement would be bifurcated from the trial of the damage issues. (D.I. 161.)

The case was tried on the liability issues to the Court without a jury from July 21, 1986 through August 18, 1986.[2] After carefully considering the sufficiency, weight, and credibility of the testimony of the witnesses, their demeanor on the stand, the documentary evidence admitted at trial, and the post-trial submissions of the parties, the Court enters the following findings of fact and conclusions of law which are embodied in this opinion as permitted by Rule 52(a), Fed.R.Civ.P.

II. THE FACTS

A. The Invention In Issue

The '698 patent in suit relates to copolymers of ethylene and higher alpha-olefins. The original patent application was filed on March 1, 1956; a continuation-in-part application was filed on January 4, 1957, and the patent issued on February 28, 1978 (PX 1).[3]

The invention of the patent is based on DuPont's discovery that the "impact strength" and the "environmental stress crack resistance" of melt processable ethylene copolymers can be unexpectedly improved by incorporating a higher alpha-olefin comonomer having five or more carbon atoms (Tr. 87-93). The '698 patent specifically discloses that the alpha-olefin comonomers which are "most outstanding in producing resins with high impact strength and excellent stress crack resistance" are

[2] Post-trial briefing was completed on January 7, 1987.

[3] "PX" refers to plaintiff's trial exhibits; "DX" refers to defendants' trial exhibits; and "Tr." refers to the trial transcripts docketed as D.I. 254-A through 254-U.

those having "preferably 5 to 18 carbon atoms per molecule" (PX 1, col. 3, ll. 19-23).

There are two aspects to the '698 patent: (1) the composition of the ethylene copolymers, and (2) the superior impact strength and the superior environmental stress crack resistance that can be obtained by using those ethylene copolymers.

1. ***The Composition of the Ethylene Copolymers***

Polymers are large molecules made by chemically joining together many small molecules called monomers. Polyethylene is the polymer made by polymerizing ethylene monomer:

ETHYLENE[4] — C=C
POLYETHYLENE — . . . -C-C-C-C-C-C-C-C-. . .

(PX 1200; Tr. 36-37)

There are two types of polyethylenes. The first, free-radical polyethylene, was developed in the 1930's (Tr. 1180), and was commercialized after the end of World War II (Tr. 52). Free-radical polyethylene is formed by highly reactive growing molecules containing free radicals. The polymer molecules formed by this process have both long and short chain branches. The structure can be analogized to a rose bush (Tr. 37-41).

The second type of polyethylene is linear polyethylene made by coordination catalyst processes developed in the 1950's (Tr. 61-62; 1181). Linear polyethylene molecules are long straight chain structures. These molecules do not have the branches that free-radical polyethylene molecules have (Tr. 62).

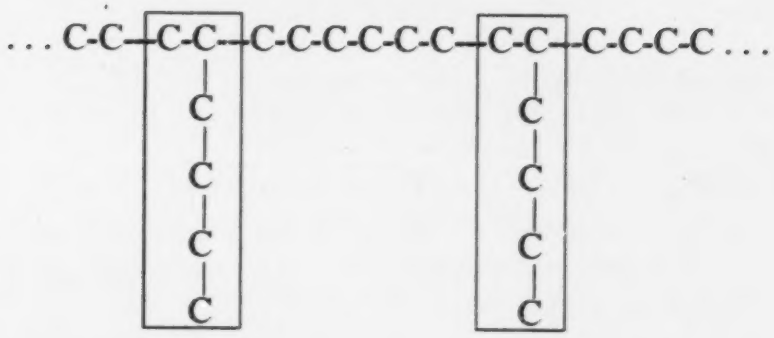
[4] In these structures, each carbon atom has attached to it hydrogen atoms (H) which are not depicted here for simplicity.

Copolymers are made by polymerizing two monomers (Tr. 66). For example, when ethylene and hexene are copolymerized, an ethylene-hexene copolymer is formed.

ETHYLENE C = C

HEXENE C = C
C
C
C
C

ETHYLENE-HEXENE COPOLYMER

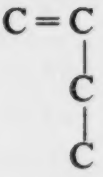


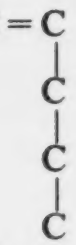
(PX 1202; Tr. 64-67)

Hexene (or hexene-1) is a six carbon "alpha-olefin." It has a double bond at one end of the molecule. Its structure, and the structures of other typical alpha-olefin comonomers are as follows:

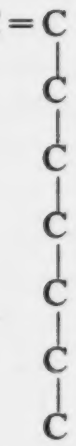
TYPICAL ALPHA-OLEFIN COMONOMERS

PROPYLENE

BUTENE 

PENTENE 

HEXENE

OCTENE 

DECENE

(PX 1203; Tr. 67-68)

The compositions described in the '698 patent are linear copolymers of ethylene and higher alpha-olefin comonomers (PX 1, col. 1, l. 61 to col. 2, l. 23; Tr. 67-68). The higher alpha-olefin comonomers begin with pentene which has 5 carbon atoms, and include hexene (6 carbon atoms), heptene (7 carbon atoms), octene (8 carbon atoms), and the remaining higher alpha-olefins through octadecene, which has 18 carbon atoms (Tr. 67). DuPont uses octene-1 in its commercial ethylene copolymers and has in some instances used decene (Tr. 1090-91). Phillips uses hexene-1 (PX 1237; Tr. 2275; 3161-62; 3168-69; 3206; 3212-13).

Copolymers made with the lower alpha-olefins, such as butene (4 carbon atoms) and propylene (3 carbon atoms), are not within the scope of the invention. The '698 patent specifically discloses that in "producing resins with high impact strength and excellent stress crack resistance . . . [p]ropylene is not effective; butene-1 shows only marginal effectiveness in this respect" (PX 1, col. 3, ll. 19-25; Tr. 110-11).

The ethylene copolymers of the '698 patent can be processed in conventional melt processing equipment (Tr. 88). Melt index is a measure of the rate at which the copolymer flows when melted and relates to the melt processability of the material. The patent specifically discloses that the ethylene copolymers of the '698 patent "have melt indexes in the range of 0.2 to 20" to enable them "to be fabricated by conventional fabricating techniques" (PX 1, col. 4, ll. 12-15).

The ethylene-higher alpha-olefin copolymers of the invention are characterized by several parameters so that they can be distinguished by external tests from linear ethylene homopolymers and from linear ethylene copoly-

mers that are rubber-like (Tr. 856, 858-60, 888-89). Those parameters are measurements of comonomer content, density, and percent crystallinity.

Comonomer content is a measurement of the presence and amount of comonomer in the ethylene-higher alpha-olefin copolymer which aids in distinguishing the copolymers of the invention from linear ethylene homopolymers and linear ethylene copolymers that are rubber-like. The '698 patent discloses that the amount of higher alpha-olefin can vary from a very small amount of comonomer (linear ethylene homopolymer has none) on the order of 1% by weight up to about 20% by weight (above 20% the copolymers become rubber-like) (Tr. 139, 859-60, 888-89).

The measurement technique for comonomer content disclosed in the patent is infrared spectroscopy (PX 1, col. 7, ll. 62-64 and Table I; Tr. 363-64, 380-90). Infrared spectroscopy comonomer content measurements as low as 1.4% by weight for a heptene (7 carbon) polymer and 1% by weight for a decene (10 carbon) copolymer (PX 1, Table I [Example 1] and col. 7, ll. 62-64) are reported. When the '698 patent application was filed in the mid-1950's, the margin of error for infrared comonomer content measurements was much greater than the degree of accuracy that can be obtained today by much later developed techniques. For example, with a hexene copolymer, the margin of error was at the very least $\pm$0.6%. Thus, a nominal infrared measurement of 1% by weight for hexene comonomer would have included copolymers with hexene comonomer contents ranging from about 0.4% to about 1.6% by weight (Tr. 3616).

Density and degree of crystallinity are also indications of the amount of comonomer, aiding to dis-

tinguish the copolymers of the invention from linear ethylene homopolymers and linear ethylene copolymers that are rubber-like. As comonomer is incorporated in the linear polyethylene chain, both the density and degree of crystallinity decrease from the values measured with linear polyethylene homopolymer alone (Tr. 132). The density data that are included in the '698 patent disclose that small amounts of comonomer can be used. Specifically, the patent discloses that with the materials the DuPont researchers were using, for linear polyethylene homopolymers the densities ranged from 0.945 to 0.960, and that as comonomer was added, the density decreased. Similarly, the patent discloses that the degree of crystallinity likewise decreased as comonomer was added (Tr. 132).

2. ***Superior Impact Strength And Environmental Stress Crack Resistance Obtained With Higher Alpha-Olefin Copolymers***

The invention of the '698 patent was not the discovery that ethylene could be copolymerized with higher alpha-olefins, nor was it the discovery of a new comonomer content range, a new density range, or a new X-ray crystallinity range (Tr. 135, 607-08). The invention was the discovery that melt processable copolymers of ethylene and higher alpha-olefins having five or more carbon atoms unexpectedly can achieve impact strength and environmental stress crack resistance properties that are superior to those obtained with free-radical polyethylene, with linear polyethylene and with comparable copolymers of ethylene (that is, with similar densities and melt index) and the lower alpha-olefins propylene (3 carbons) and butene (4 carbons) (Tr. 86-93).

Impact strength is a measure of a polymer's ability to sustain a sudden mechanical blow. Impact strength tests

include the Izod impact test in which a sample is struck by a weight that falls in a pendulum fashion and the Elmendorf tear strength test in which a film sample is torn by a weighted pendulum which rapidly tears the film (Tr. 88-90; PX 601, which is the 1955 ASTM D 689-44 for Elmendorf Tear Strength).

Environmental stress crack resistance is a measure of the length of time that a polymer sample can be subjected to a stress load without cracking. The stress load can be imposed by bending the sample. The environment can be heated air or liquids which cause stress cracking such as detergents. One of the standard environmental stress crack resistance tests is the Bell ESCR test in which samples are notched and bent and placed in the stress cracking agent Igepal (Tr. 90-92, 932-36; PX 135; PX 1256 at 389-93). Another stress test is the hoop stress test for plastic pipe (Tr. 92-93).

The '698 patent discloses that superior impact and environmental stress crack resistance properties can be obtained in ethylene copolymers with alpha-olefins containing five or more carbons up to eighteen carbons. Based on prior experience on the effect of branching in free radical polyethylene, this result was totally unexpected and unpredictable prior to DuPont's discovery in 1955 (Tr. 99-103).

When an alpha-olefin comonomer molecule is incorporated in an ethylene copolymer, a side chain or branch is formed (Tr. 66). This can be seen graphically in the structure diagram of an ethylene-hexene copolymer (*supra* at A30). In the mid-1950's, it was known on the basis of prior work with free-radical polyethylene that decreasing the number of branch points would cause an impairment of both stress crack resistance and impact

toughness (PX 1, col. 1, ll. 51-60; Tr. 94-96). In other words, to improve the properties of stress crack resistance and impact toughness, one would increase the number of branch points. On the basis of this experience, one skilled in the art would have expected lower alpha-olefins to be more effective than higher alpha-olefins in improving these properties. When lower and higher alpha-olefins are separately copolymerized with ethylene in equal amounts by weight, the lower alpha-olefin comonomers being of lower molecular weight will give more branch points in the copolymer (Tr. 102). Dr. John Beasley explained this by comparing copolymers made with butene, which has four carbons, and octene, which has eight. At equal weights, twice as many branch points will be obtained using butene than will be obtained with octene. Thus, to one skilled in the art in the 1950's, better stress crack resistance and impact strength would have been expected with the butene copolymer (Tr. 101-09).

Unexpectedly, DuPont discovered the opposite to be true. The higher alpha-olefin copolymers achieved these superior properties (Tr. 101, 103, 109). Based on this discovery, DuPont filed the applications for the '698 patent in 1956 and 1957 from which the '698 patent issued.

The specifications of the '698 patent clearly disclose the existence of unexpected superior properties of the invention of the '698 patent and they read in pertinent part:

> a. A copolymer which can be extruded into film . . . surprisingly, with an impact toughness higher than any film forming polyethylene resin ever tested.
>
> b. A copolymer which can be extruded into wire coatings . . . which, surprisingly, have stress crack

resistance at least equal to any other wire coating polyethylene resin ever tested.

c. A copolymer which can be extruded into pipe . . . which, surprisingly, has a longer time to failure when subjected to internal pressure both at room temperature and at elevated temperatures than does any other pipe forming polyethylene resin ever tested.

d. A copolymer which can be injection molded into various articles . . . which, surprisingly have good impact toughness and stress crack resistance at least equal to any injection moldable resin ever tested (PX 1, column 2, lines 24-47).

* * *

Those which are most outstanding in producing resins with high impact strength and excellent stress crack resistance while at the same time being relatively high in crystallinity contain more than 4 carbon atoms and preferably 5 to 18 carbon atoms per molecule. Propylene is not effective; butene-1 shows only marginal effectiveness in this respect. (PX 1, column 3, lines 19-25.)

Phillips argues that it is improper to ascertain the invention of a patent from the specifications outside of the patent claims. But this is not entirely so. The Supreme Court held in United States v. Adams, 383 U.S. 30, 40 (1966), that "it is fundamental that claims are to be construed in the light of the specifications and both are to be read with a view to ascertaining the invention." Other courts have likewise held that limitations that are essential to an invention are to be read into the claims in ascertaining the invention. Roberts Dairy Co. v. United States, 530 F.2d 1342, 1352-53 (Ct.Cl. 1976); Stanley Works v.

McKinney Mfg. Co., 520 F.Supp. 1101, 1110 (D.Del. 1981). In this case the superior impact strength and environmental stress crack resistance which are essential elements of the invention are distinctly disclosed in the specifications as the surprising aspect of the copolymers involved and they must be read with the claims in ascertaining the invention.

III. COLLATERAL ESTOPPEL DEFENSE

As noted above, just prior to the commencement of trial in this Court, Phillips moved for summary judgment to dismiss DuPont's action under the doctrine of collateral estoppel. (D.I. 210.) Consideration of that motion was deferred until after trial. Phillips' motion must now be decided.

Phillips points out that the Patent Office conducted a merged reissue and reexamination proceeding of DuPont's '698 patent over an extended period of time. (D.I. 211A at A3-9.) In a final office action, Edward J. Smith, Patent Examiner, on May 12, 1986, rejected all the claims of the '698 patent. (*Id.* at 102-119.) On June 11, 1986, DuPont appealed the Examiner's final office action to the Board of Patent Appeals and Interferences. (*Id.* at 133-34.) On August 6, 1986, the Assistant Commissioner of Patents entered an Order staying all further proceedings in the DuPont reissue/reexamination pending in the Patent Office. (D.I. 257, App. C.)

Phillips strenuously argues that the Examiner's Final Office Action of May 12, 1986, rejecting all the claims of the '698 patent, is entitled to preclusive effect against DuPont in this Court which it contends is a collateral proceeding. The Court finds Phillips' contention to be without legal merit and therefore will deny Phillips' summary judgment motion for the following reasons.

First, Phillips' argument is premised on the assumption that a patent examiner's rejection of the '698 patent claim is a final decision of an administrative agency. The Court concludes that this assumption is incorrect. A patent examiner's rejection of claims in a reissue/reexamination proceeding is not a final decision by the Patent Office. Any final Patent Office decision in the reissue/reexamination matter is a question that would have to be determined by the Board of Patent Appeals and Interferences. MPEP §§ 1442.02 and 2286. (D.I. 257, App. C.) But since the reissue/reexamination proceedings in the Patent Office were stayed (*id.,* App. C), the Board of Patent Appeals and Interferences has never considered the Examiner's rejection of the claims, has never made a final determination, and never will, because the MPEP provides that the decision of this Court on validity and enforceability of the '698 patent will be considered controlling in the Patent Office. *See* MPEP § 2286 (*id.,* App. C). Phillips has cited no precedent, and the Court has found none on its own, which holds that an Examiner's final office action in a reissue/reexamination proceeding is a final decision of the Patent Office which should be given collateral estoppel effect by this Court.

Second, Phillips' effort to bring an Examiner's final office action under the Supreme Court's decision on collateral estoppel in Blonder-Tongue v. University Foundation, 402 U.S. 313 (1971), is equally unavailing. Phillips argues that in *Blonder-Tongue,* the Supreme Court has established that the doctrine of collateral estoppel prevents a patentee from relitigating the validity of claims of a declared invalid patent in a "prior proceeding." But Phillips ignores the fact that the only "prior proceeding" covered by the collateral estoppel rule in *Blonder-Tongue* was a "trial" in which there has been a "judicial resolution

of the same issue." In *Blonder-Tongue*, there had been a prior decision of patent invalidity by a United States District Court after trial. Thus, the Supreme Court held in that situation, that collateral estoppel could be pleaded and given effect in subsequent litigation if the patent owner had been given a full and fair opportunity to pursue his claim in the prior trial "procedurally, substantively and evidentially." *Blonder-Tongue*, 402 U.S. at 333. Apart from the fact that the Examiner's rejection was not a final decision of the Patent Office, it would be absurd to hold that an Examiner's final office action before a decision was reached by the Board of Patent Appeals and Interferences in the stayed reissue/reexamination proceedings was preclusive in this Court. The proceedings to the point reached before the Examiner afforded no evidentiary hearing, no live testimony in order to determine credibility, no right of cross-examination, and no application of the rules of evidence. Certainly the absence of these features before the Examiner cannot be said to fulfill the *Blonder-Tongue* requirements of a full and fair opportunity "procedurally, substantively and evidentially."[5] In contrast to the mere paper record considered by the Examiner, this Court conducted a full trial on the issues of infringement, validity, and enforceability of the '698 patent between July 21, 1986 to August 18, 1986. The parties called a total of 29 fact and expert witnesses to testify and introduced 999 exhibits into evidence. The trial transcript covers more than 1900 pages of direct testimony and over 1400 pages of cross-examination. (D.I. 554 A-U.)

Trial was not merely limited to a comparison of the '698 patent and prior art references. Extensive and detailed evidence was also received on DuPont's unex-

[5] This Court would have been faced with a different problem had the reissue/reexamination proceedings ended with a final decision of the Patent Office. This, however, did not occur in this case.

pected and surprising discovery that superior impact strength and stress crack resistance could be obtained with ethylene-higher alpha-olefin copolymers, on Phillips' failure to make that discovery when its researchers also worked in the same field in the mid-1950's, on Phillips' later recognition of DuPont's discovery and the commercial success of that invention.

The Court, therefore, holds that the Examiner's final office action rejecting all claims of the '698 patent in the now terminated reissue/reexamination proceedings[6] is not entitled to a preclusive effect in this Court based on the doctrine of collateral estoppel, and Phillips' summary judgment motion will be denied.

IV. VALIDITY

A. Burden of Proof

The parties disagree as to which has the burden of proof on the issue of patent validity. Phillips contends that its "burden under [35 U.S.C.] § 282 is met simply by showing *prima facie* invalidity based on the final office action in the reissue proceeding" (D.I. 259 at 33), or as it otherwise argued, DuPont has the burden of overcoming the deference that this Court must give to the Examiner's rejection of the claims of the '698 patent in the reissue/reexamination proceedings. The Court finds Phillips' argument to be without merit.

35 U.S.C. § 282 provides, in pertinent part:

> A patent shall be presumed valid. . . . The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.

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[6] The protestor participation reissue/reexamination proceedings conducted by the Examiner in this case were abolished in 1982 by the Patent Office for the future. (D.I. 257, App. E.)

The party asserting invalidity must prove invalidity with facts supported by clear and convincing evidence. Loctite Corp. v. Ultraseal, Ltd., 781 F.2d 861, 872 (Fed. Cir. 1985). That burden of persuasion is "permanently on the party asserting invalidity," Richdel, Inc. v. Sunspool Corp., 714 F.2d 1573, 1579 (Fed. Cir. 1983), is "constant and never changes," American Hoist & Derrick Co. v. Sowa & Sons, 725 F.2d 1350, 1361 (Fed. Cir. 1984), and is "never annihilated, destroyed, or even weakened, regardless of what facts are of record," ACS Hosp. Systems Inc. v. Montefiore Hosp., 732 F.2d 1572, 1574-5 (Fed. Cir. 1984); Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530 (Fed. Cir. 1983). These holdings of the Federal Circuit are overwhelming and the presumption of validity created by § 282 is applicable to this case in this Court. The Federal Circuit has also noted in Fromson v. Advance Offset Plate, Inc., 755 F.2d 1549, 1555 (Fed. Cir. 1985):

> The Examiner's decision, on an original or reissue application, is never binding on a court. It is, however, evidence the court must consider in determining whether the party asserting invalidity has met its statutory burden by clear and convincing evidence.

In short, Phillips bears the burden of persuading this Court that the '698 patent is invalid by clear and convincing evidence. The fact that the reissue/reexamination examiner rejected the claim is only one piece of the total evidence presented at trial which this Court must consider in determining whether Phillips has met its burden of proving invalidity. That piece of evidence, however, is not binding upon this Court and it does not weaken the presumption of validity or reduce Phillips' burden of proving invalidity by clear and convincing evidence.

B. Phillips' Anticipation Defenses

Phillips contends that the claims of the '698 patent are invalid as anticipated under 35 U.S.C. § 102 by the prior work of Phillips and by other prior art.

1. ***Phillips' Work In The Mid-1950's***

DuPont concedes that in 1954-55, Donald Witt and Gerald Leatherman, researchers for Phillips, made ethylene copolymers using both lower alpha-olefins (proplyene and butene) and higher alpha-olefins (pentene and hexene) (Tr. 1279) and that they were disclosed in a patent application which they filed in August 1956.[7] (PX 88.) Phillips contends that this earlier work of Phillips' researchers, which was not abandoned, suppressed, or concealed, invalidates the claims of the '698 patent under 35 U.S.C. § 102(g). The Court is unable to agree because Phillips' researchers, unlike DuPont, failed to discover that superior impact strength or environmental stress crack resistance can be achieved with higher alpha-olefin copolymers.

Indeed, the Izod impact strength of the butene copolymers made by Witt and Leatherman was *superior* to their pentene and hexene copolymers. (PX 88, Table VI; Tr. 168-73; 2059; 1472).[8] These disclosures are just the opposite of DuPont's discovery.

Phillips also argued that by the fall of 1955, "Phillips' researchers also determined" that the Witt and Leatherman pentene and hexene copolymers "exhibited excellent toughness" (D.I. 259 at 13), citing to DX 858 and the

[7] After the claims of application were rejected, the application was thereafter abandoned. (PX 88.)

[8] The Izod impact strength reported for butene copolymers was 4.0-10 ft.lbs./inch notch compared with 1.7-2.8 reported for pentene copolymers and 3.5-4.3 reported for hexene copolymers. (PX 88, Table VI, Tr. 168-72.)

testimony (Tr. 1935-38) of Professor Bryce Maxwell, one of Phillips' experts. Phillips' contention is based on stress-strain multiplication analysis which Professor Maxwell admitted on cross-examination cannot be used to determine impact strength. (Tr. 2123.)[9]

Phillips has also throughout its post-trial briefs created the impression that its researchers concluded in 1955 that the Witt and Leatherman pentene and hexene copolymers had environmental stress crack resistance superior to that of lower alpha-olefin propylene and butene copolymers.[10] The evidence at trial demonstrated that Phillips' researchers never arrived at that conclusion or made that discovery.

It is true that the Witt and Leatherman application contains specific stress crack data for propylene and butene copolymers, but no such data is given for pentene and hexene copolymers. (PX 88, Table VI.) The application contains no hints whatsoever of the possibility that pentene and hexene copolymers could be superior to propylene and butene copolymers in stress crack resistance.[11] Indeed, Mr. Leatherman admitted on cross-examination that he and Mr. Witt did not discover that higher alpha-olefin copolymers had impact strength or stress crack resistance superior to that of the lower alpha-olephin (propylene and butene) copolymers. (Tr. 2541-44.) Their contemporaneous actions in 1954 and 1955

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[9] No evidence was introduced at trial to show that anyone at Phillips ever applied Professor Maxwell's multiplication technique to the data for the Witt and Leatherman polymers.

[10] Neither Witt nor Leatherman did any further work with pentene or hexene copolymers after 1955. (Tr. 2536; 2569.)

[11] The disclosures in the Witt and Leatherman application concerning stress crack resistance to which Phillips refers in its brief (D.I. 295 at 16, citing PX 88 at L000007 and L000010), do not relate to higher alpha-olefin copolymers. The only stress crack data in the application was for the lower alpha-olefin propylene and butene copolymers. (Tr. 1715; Tr. 2544-45.)

confirm that Witt and Leatherman prepared detailed research reports summarizing their work on propylene and butene copolymers, but they did not prepare any reports on copolymers made with higher alpha-olefins pentene or hexene. (Tr. 2547-48; 2570.) Also after making the pentene and hexene copolymers, they abandoned them and returned to using propylene and butene copolymers. (Tr. 2536; 2569; DX 204, 208A, 215, 227, 230, 234.)

Phillips belatedly produced on March 5, 1986, a few months before trial, the notebook of John N. Scott, a Phillips researcher. (DX 206.) The stress crack data contained in that notebook show that butene and pentene copolymers achieved comparable stress crack resistance, while the hexene copolymers had not reached that level. (Tr. 188.) Mr. Scott admitted that his results showed no difference between butene, pentene or hexene (Tr. 2755) and Mr. J. Paul Hogan, a principal witness for Phillips, testified that there was no way of telling which would have the highest stress crack resistance. (Tr. 2385-86.) But even if the Scott data could be said, as Phillips contends, to show any improvement of stress crack resistance, that data was suppressed and concealed for more than 30 years and reliance upon that data, as uncertain as it is, cannot be relied upon to support Phillips' prior invention defense. In short, Phillips has not proved by clear and convincing evidence that the pentene and hexene copolymers made by Witt and Leatherman were superior to propylene and butene copolymers in impact strength or stress crack resistance. The Court further finds that Phillips has not borne its burden of proving that Witt and Leatherman's pentene and hexene copolymers inherently had stress crack resistance superior to that of the lower alpha-olefins propylene and butene.

However, even if Phillips had established at trial that the Witt and Leatherman pentene or hexene copolymers inherently had such superior impact strength or stress crack resistance, its prior invention defense would still be unavailing because it is clear that these superior properties were neither recognized nor appreciated by Phillips prior to DuPont's discovery of those superior properties in the higher alpha-olefin copolymers.

To establish prior invention, there must be evidence that the alleged prior inventors appreciated at the time of their work all the elements of the invention. Standard Oil Company v. Montedison, 494 F.Supp. 370 (D.Del. 1980), *aff'd,* Standard Oil Company v. Montedison, 664 F.2d 356 (3d Cir. 1981); *see also* Kimberly-Clark Corp. v. Johnson & Johnson, 745 F.2d 1437, 1444 (Fed.Cir. 1984). Thus, Phillips not only failed to prove that the Witt and Leatherman pentene and hexene copolymers had superior impact strength and stress crack resistance over propylene and butene, but it also failed to prove by contemporaneous evidence that it recognized that these superior properties could be obtained with higher alpha-olefins.

As noted above, the only stress crack resistance data for the Witt and Leatherman pentene and hexene copolymers appear in one document in Mr. John Scott's notebook number 6606 (DX 206) which Phillips did not produce, although called for, until March 5, 1986. (PX 1364.) Phillips advances the argument that the production of this notebook negates DuPont's contention of abandonment, suppression or concealment. The Court finds otherwise. In the first place, the Scott data is not conclusive that the pentene and hexene copolymers of Witt and Leatherman were superior to the lower alpha-olefins. But even if it did make that showing, disclosing

this data after 30 years is not evidence negating the argument of abandonment, suppression or concealment.

DuPont's contention that Phillips abandoned, suppressed or concealed any data relating to the stress crack resistance of Witt and Leatherman's pentene and hexene copolymers is a valid one. There was nothing in the talks of Dr. William Reynolds, of Phillips Research Division, presented at various conferences or in papers presented at American Chemical Society meetings which disclosed the superior stress crack resistance of pentene, hexene, or other higher alpha-olefins. (Tr. 2690-93.)

Likewise, the reference in the Witt and Leatherman patent application (PX 88) relied upon by Phillips to negate abandonment, suppression and concealment proves nothing with regard to stress crack resistance of copolymers with higher alpha-olefins. For example, the reference in the Witt and Leatherman application to the "high degree of flexibility" (PX 88 at L000007) continues on to disclose that the "copolymers have very high environmental stress crack resistance value greater than 420 hours." This, however, was the stress crack resistance obtained by Witt and Leatherman with propylene and butene copolymers. (PX 88 at Table VI, L000016.) Phillips' reliance on references in the Witt and Leatherman application to copolymers as being useful for pipe, tubing or film because of their "stress cracking properties" (PX 88 at L000010) does not anticipate DuPont's discovery. This is so because Mr. Leatherman testified at trial that such general references to stress cracking in the application were based on stress crack data for propylene and butene copolymers. (Tr. 2545-46.) Furthermore, Mr. Leatherman testified at his deposition that he did not recall any pipes, tubing or film being made with the copolymers he and Mr. Witt prepared. (PX 1402 at 72-73.)

It is also significant that the actions Phillips took in regard to ethylene alpha-olefin copolymers in the latter part of the 1950's and early 1960 were consistent with Phillips' failure to discover, or even to recognize, that superior properties can be achieved with higher alpha-olefin copolymers. The first ethylene alpha-olefin copolymers Phillips introduced commercially in 1958 were made with butene. (Tr. 2268.) Almost ten years passed before Phillips in 1967 eventually introduced a higher alpha-olefin hexene copolymer. (Tr. 2275; D.I. 137 at 15; DX 2580.)

In the early 1960's Phillips continued to rely on butene and considered using propylene. When a project was undertaken in 1960 to develop a "copolymer which will compete with high pressure polyethylene in film applications," Mr. Hogan listed the comonomers to be studied as follows:

I. Comonomers
   - A. 1-Butene
   - B. Propylene
   - C. 1-Butene-Propylene Mixtures.

(PX 121; Tr. 159.)

Phillips did not introduce its first ethylene higher alpha-olefin copolymer to the market until 1967, five years after DuPont introduced its higher alpha-olefin copolymers to the market and more than ten years after DuPont filed for the '698 patent. That Phillips' copolymer was made with hexene. (Tr. 2275; D.I. 137 at 15.) The manner in which Phillips entered the higher alpha-olefin copolymer business supports the significance of the invention of the '698 patent. The evidence also strongly supports the inference that Phillips initiated its program to switch from butene to hexene only after it learned of DuPont's discovery that the higher alpha-olefin copolymers have superior properties.

On June 4, 1963, the DuPont Canadian patent (the counterpart to the '698 patent in suit) issued. (PX 4.) Phillips was using four carbon butene as a comonomer at that time. (Tr. 2268-75; D.I. 137 at 14-15.) The DuPont Canadian patent (PX 4) specifically disclosed that superior impact toughness and environmental stress crack resistance can be achieved by using higher alpha-olefins above butene (i.e., pentene and up). (Tr. 205-06.)

On July 9, 1963, a month after the issuance of the Canadian patent, Phillips held a Marlex Task Force Meeting. (PX 125.) The environmental stress crack resistance of Phillips' ethylene-butene copolymers was considered and the Task Force reported that "ESC improvements resulting from incorporation of larger chain olefins are being studied for PF bottle grade resins." (PX 125 at 4.)

On July 12, 1963, three days after the Task Force meeting, Phillips made an ethylene-hexene copolymer which was then immediately tested for environmental stress crack resistance. (PX 136 at L95078; Tr. 2425.) The stress crack resistance time of greater than 1,000 hours for this sample, which Phillips obtained sometime after August 7, 1963 (Tr. 2425), was the earliest Phillips data Mr. Hogan could point to in support of the statement in an August 1964 memorandum (DX 405; PX 126) that "we have found that ethylene/hexene-1 PF copolymers in the processable melt index range possess higher ESCR than ethylene/butene copolymers." (Tr. 2420-24.)

In January 1964, Phillips issued a Research Division Progress Report entitled "Improved Methods for Preparation of Marlex Polymers," and according to a later report, dated May 24, 1965, the research studies discussed in that January 1964 report "showed that improved ESCR values

could be obtained by utilizing hexene-1 instead of butene-1 as the process comonomer." (PX 34 at L08134-35; Tr. 2447-48.) Although Phillips "searched and searched" for the January 1964 report (Tr. 2450), it was never found and produced. Mr. Hogan, who prepared a portion of the missing January 1964 report and who received a copy (Tr. 2451), had no recollection whether the missing report referred to DuPont's Canadian patent (the counterpart to the '698 patent in suit). (Tr. 2451-52.) Because of the timing, a strong inference persists that Phillips turned to a closer examination of copolymers with higher alpha-olefins only after the superior properties were disclosed in 1963 in DuPont's Canadian patent.

Phillips' work with hexene and other higher alpha-olefins continued after the January 1964 report. In November 1965, Mr. Hogan and Mr. A. G. Kitchen issued a report which summarized work done with several higher alpha-olefins after June 1963 when DuPont's Canadian patent issued. (PX 83; Tr. 2452-54.) Hogan and Kitchen stated at the outset of the November 1965 report that:

> Bench reactor studies have shown that the environmental stress crack resistance (ESCR) of processable PF polymers is greatly increased by the use of alpha olefins other than butene-1 as co-monomers. Hexene-1, which introduces butyl branches to the polymer chain, was the preferred comonomer.

(PX 83 at 1, L04404.)

In the "Results And Discussion" section of the report, Messrs. Hogan and Kitchen stated, "it is quite apparent that hexene-1 incorporation caused a large increase in ESCR, compared to butene-1 incorporation." (PX 83 at

3, L04407.) This result is graphically expressed in Figure 2 of that report which shows the significantly better stress crack resistance Phillips obtained with hexene compared to butene. (PX 83, Figure 2, reproduced as chart PX 1215.)

Mr. Kitchen at his deposition testified that he was surprised by the large increase in stress crack resistance achieved with hexene in place of butene and he also explained that similar results were obtained with octene, decene and dodecene. (D.I. 95 at 47.)

Based on all this evidence the Court concludes that Phillips has not proved by clear and convincing evidence that the research efforts or patent application of Witt and Leatherman in the mid-1950's anticipated DuPont's invention of the '698 patent so as to invalidate that patent under 35 U.S.C. § 102(g).

2. *Phillips' Other Anticipation References*

Phillips has cited a handful of other references in support of it anticipation defense, viz: Vandenberg U.S. Patent 3,058,963 (DX 100); Vandenberg U.S. Patent 3,015,690 (DX 101); Belgian Patent 533,362 (DX 107A); Nowlin et al. U.S. Patent, 3,219,649 (DX 77); Brown U.S. Patent 2,728,752 (DX 14); Hogan et al. U.S. Patents 2,846,425 (DX 44) and 2,825,721 (DX 45).[12] Curiously, Phillips argues that this Court should combine and cull the teachings of its references to build an anticipation. This the Court refuses to do because it is contrary to well

[12] While Phillips stated in its opening brief (D.I. 259 at 47-48) that it relied upon three other references as anticipation, viz., the Buckley and Ray article (DX 121); Hagemeyer et al. U.S. Patent 2,899,413 (DX 41); and the Belgian Patent 538,782 (DX 106A), these references were not discussed in either Phillips' opening or reply brief except in its defense of obviousness. Therefore, the Court will treat these references accordingly.

established law. The Federal Circuit has held time and again that anticipation is a defense that is established only when a party challenging validity proves that a single prior art reference discloses each and every element of the claimed invention. *E.g.,* Great Northern Corp. v. Davis Core & Pad Co., Inc., 782 F.2d 159, 165 (Fed. Cir. 1986); Structural Rubber Products v. Park Rubber, 749 F.2d 707, 715 (Fed. Cir. 1984); Studiengesellschaft Kohle v. Dart Industries, 726 F.2d 724, 727 (Fed. Cir. 1984); W. L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1541 (Fed. Cir. 1983). As a matter of fact, none of these other references teach the achievement of superior impact strength or stress crack resistance with ethylene higher alpha-olefin copolymers, which was the discovery and invention of DuPont's '698 patent.

But even when these other references are considered in combination as suggested by Phillips, they do not support Phillips' anticipation defense.

Vandenberg '963 and '690 Patents and Belgian Patent

The Vandenberg '963 patent is directed to a coordination catalyst system with which "[a]ny ethylenically unsaturated hydrocarbon or mixtures thereof may be polymerized." (DX 100, col. 4, ll. 45-46.) Vandenberg '963 goes on to state:

> Exemplary of the ethylenically unsaturated hydrocarbons which may be homopolymerized or mixtures of which may be copolymerized are the linear 1-olefins such as ethylene, propylene, butene-1, hexene-1, heptene-1, octene-1, octadecene-1, dodecene-1, etc., and branched chain 1-olefins and other olefins such as isobutylene, cis-butene, diisobutylene, tert-butylethylene, 4- and 5-methylheptenes-1, tetra-

> methylethylene, and substituted derivatives thereof such as styrene, a-methylstyrene, vinyl-cyclohexane, diolefins such as hexadiene-1,4, 6-methylheptadiene-1,5 and conjugated diolefins such as butadiene, isoprene, pentadiene-1,3, cyclic olefins such as cyclopentadiene, cyclohexene, 4-vinyl-cyclohexene-1 terpenes such as B-pinene, etc.

(DX 100, col. 4, ll. 63 to col. 5, l. 1.) This paragraph merely offers, as Professor Charles Price, one of Phillips' experts, concluded, a "[l]ot of possibilities." (Tr. 1540.)

The Vandenberg '963 patent contains sixty-four examples, principally of the homopolymerization of ethylene or propylene, which confirm that Vandenberg's process results in extremely high molecular weight polymers. In almost every example, Vandenberg's reported value for reduced specific viscosity[13] shows that the resulting polymer had a zero melt index and was not melt processable. (Tr. 1532.)

The only example in Vandenberg which discloses a copolymer made from ethylene and an alpha-olefin is Example 53, in Table V at columns 11 and 12. (Tr. 1306, 1532.) This ethylene-octene-1 copolymer made in a batch polymerization contained 5.8% octene and had a reduced specific viscosity of 9.0. (DX 100, Table V.) This copolymer was of very high molecular weight, on the order of 1,000,000, and would be a zero melt index or no flow copolymer. (Tr. 1532; Tr. 3495-96.) It was not melt processable in the mid-1950's. (Tr. 87-88.) Vandenberg's copolymer was not tested for impact strength or stress crack resistance. (Tr. 3474-75.)

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[13] Reduced specific viscosity is an indication of molecular weight (Tr. 1307; DX 100, col. 5, ll. 66-68). The higher the reduced specific viscosity, the greater the molecular weight (see Tr. 41-42; Tr. 2696).

In short, Vandenberg's '963 patent does not disclose a melt processable ethylene-octene-1 copolymer or any other melt processable higher alpha-olefin copolymers. Vandenberg's '963 patent also contains no hint of the superior impact strength or stress crack resistance of such copolymers.

Mr. Edwin J. Vandenberg, the inventor, admitted at trial that he had not discovered that ethylene higher alpha-olefin copolymers would have superior impact strength and stress crack resistance over butene copolymers at the same melt index and density (Tr. 3497-98; 3501), nor did he predict this discovery in 1955 when he made his ethylene-octene copolymers. (*Id.*) Indeed, Mr. Vandenberg, a highly skilled polymer chemist (Tr. 3464-65), admitted that even today he had no explanation why the stress crack resistance of the higher alpha-olefin copolymers is superior to the propylene and butene copolymers. (Tr. 3500-00A.)

Furthermore, Phillips' attempt to rely on the Vandenberg '690 patent (DX 101) as an anticipation, either alone or combined with the Vandenberg '963 patent, highlights the deficiencies of the '963 patent. The Vandenberg '690 patent discloses a process for polymerizing olefins using hydrogen to control the molecular weight and refers to the application for the Vandenberg '963 patent as describing a process which can be improved by such use of hydrogen. (DX 101, col. 1, 11. 48-55.) The Vandenberg '690 patent has no specific examples of ethylene alpha-olefin copolymers.

Phillips' argument can be reduced to the following two propositions that (1) one skilled in this art would use hydrogen as taught by the Vandenberg '690 patent to reduce the molecular weight of the ethylene-octene

copolymer (Example 53) of the Vandenberg '963 patent to a melt processable range, and (2), if Example 53 were modified with such use of hydrogen, that copolymer produced inherently would have impact strength or stress crack resistance superior to that of the lower alpha-olefin propylene and butene copolymers.

Phillips, however, did not prove its second proposition of inherency at trial any more than it did with the Witt and Leatherman prior invention defense. Furthermore, the first proposition is incorrect factually. Mr. Vandenberg was highly skilled in this art and was the inventor of both the '690 and '963 patents. (Tr. 3462-65.) He knew that hydrogen could be used to reduce the molecular weight of polymers before he made the high molecular weight, no flow ethylene-octene copolymer (Example 53) of his '963 patent. (Tr. 3493-94.) Yet, even Mr. Vandenberg never thereafter used hydrogen to reduce the molecular weight of that ethylene-octene copolymer. He did something else.

After Mr. Vandenberg had conducted his Example 53 experiment (Run 13) using 10 grams of octene to 1.9 grams of ethylene (Tr. 3468-69; PX 11 at 1), he reported that "it is probable that some useful copolymers may be developed" and that "it may be possible to obtain sufficient copolymerization by operating at the very high monomer ratios that can be obtained by using the more reluctant monomer (as isobutylene, octene-1, etc.) as solvent for the polymerization." (PX 930 at 4, Tr. 3479-80.) Thereafter, Vandenberg attempted two runs using octene to ethylene ratios of about 25 to 1, or about 5 times the ratio of Example 53. Insignificant amounts of product were obtained. (Tr. 3481-86; PX 11 at 6, 10.) Mr. Vandenberg then made another attempt to make a

copolymer using a 25 to 1 ratio of octene to ethylene (PX 12, Run 8) and he obtained a polymer containing 31% octene and having a reduced specific viscosity of 10.0, even higher than his Example 53 copolymer. (Tr. 3487-90.) From this Vandenberg concluded (PX 13 at 2) that "copolymerizations go poorly, in general, with this system." No further work was done by Mr. Vandenberg or others at Hercules, Inc., on copolymers of ethylene with an alpha-olefin with five or more carbon atoms. (Tr. 3491-93.)

Finally, the Belgian '362 patent (DX 107A), which Phillips relies on in combination with Vandenberg '963 to argue that claims 1, 10 and 12 are anticipated (D.I. 259 at 53-54), only discloses ethylene homopolymers. (Tr. 1536-37.) The Vandenberg '963 patent refers to this Belgian patent only for its description of "a new process of polymerizing ethylene to a high molecular weight polyethylene" (DX 100, col. 1, ll. 14-17), not for uses or properties for the polymers of Vanderberg '963. (Tr. 1537-38.) The Court finds nothing in either Vandenberg patent which discloses that the Vandenberg copolymers would have the properties and uses of the Ziegler homopolymers (the Belgian patent '362) or that Vandenberg copolymers would meet the numerical values for tear strength[14] in Claim 1 and for hoop stress in Claim 12 of the '698 patent. The Court concludes that Phillips has not sustained its burden by clear and convincing evidence that the invention of the '698 patent was anticipated by the two Vandenberg patents or the Belgian patent.

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[14] Claim 1 of the '698 patent provides for an Elmendorf tear strength limitation of 150-400 grams per mil and Claim 12 refers to a copolymer in the form of pipe "characterized by withstanding 3000 hours at hoop stress at 750 psi and a temperature of 60°C." (PX 1, col. 13, ll. 24-25; col. 14, ll. 30-31.)

District Court Opinion

The Nowlin et al. '649 Patent

The Nowlin et al. '649 patent (DX 77) also discloses a single ethylene higher alpha-olefin copolymer (ethylene-hexene) that is not melt processable. Dr. Charles Price, a Phillips' expert witness, admitted that fact and also testified that because this ethylene-hexene copolymer would not be melt processable, it could not be used to form bottles or extruded into pipe as stated in col. 9, lines 46-51 of the Nowlin et al. patent. (Tr. 1551-52.)

Example II of Nowlin is the only example of an ethylene higher alpha-olefin copolymer (ethylene-hexene). Ethylene homopolymers are disclosed in Examples I and III of Nowlin et al. The Example II hexene copolymer, like the Example I no flow, zero melt index ethylene homopolymer, was difficult to grind in a blender. (DX 77, col. 6, ll. 50-74 and col. 7, ll. 68-70.)

Although not stated in Nowlin et al., the melt index of the Example II ethylene-hexene copolymer was 0.057. (Tr. 1545-46; PX 1304; PX 1302 at L07685, Run 6868-14.) Nowlin et al., however, knew how to reduce the molecular weight of a polymer. The Example III ethylene homopolymer they made had a melt index of about 6.0. Yet, there was also a severe decrease in falling ball impact strength. (DX 77, col. 8, ll. 57-65.)

Phillips again makes the argument based on two propositions that (1) one skilled in this art would reduce the molecular weight of the Example II ethylene-hexene copolymer of Nowlin et al. to the melt processable range, and (2), if Example II were modified to so reduce molecular weight, the copolymer inherently would have impact strength or stress crack resistance superior to that of the lower alpha-olefin propylene and butene copolymers.

Phillips, however, failed to prove at trial the second inherency proposition. The facts are also contrary to the premise in its first proposition that one skilled in the art would reduce molecular weight. Dr. Nowlin and his co-inventor Lyons, like Vandenberg, were skilled in this art and knew how to reduce the molecular weight of a polymer. Yet after obtaining the ethylene-hexene copolymer of Example II of their patent, they did not rerun that experiment to reduce the molecular weight of that copolymer. Instead, they suggested doing what Vandenberg did—add more comonomer:

> In Run 6694-11 and -14 [the 6694 should be 6868] efforts were made to build-in a plasticizer in the form of 1-hexene. Preliminary evaluations listed in Table XI show there to be no marked difference in polyethylene and these copolymers which also are very stiff and insoluble in hydrocarbons. Larger 1-hexene/ethylene ratios should be investigated in the polymerizations to increase the plasticity and other properties.

(PX 1302 at L07672.) Nowlin et al., like Vandenberg, were skilled polymer researchers, yet they all missed the discovery made by DuPont that is the subject of the '698 patent.

The Brown '752 Patent

Standard Oil's Brown '752 patent (DX 14) differs from Phillips' other anticipation references in that it relates to free-radical polymerization, as opposed to coordination polymerization. (Tr. 1778.) Brown specifically relates to the use of tertiary butyl ethylene as a "polymerization modifier" in the free-radical initiated

polymerization of ethylene. (DX 14, col. 1, ll. 51-58; col. 2, ll. 12-21.)

Brown also discloses that it is not clear what the tertiary butyl ethylene "polymerization modifier" does. Brown explains that:

> Whether the tertiary butyl ethylene acts by increasing the solubility of polyethylene in ethylene during polymerization, or by modifying the polymerization process, in somewhat the same manner as do higher temperatures or higher pressures, to, for example, increase branching and decrease polymer density, or whether some other effect, such as chain termination, is predominant, is not determined.

(DX 14, col. 2, ll. 19-26.)

> Tertiary butyl ethylene, preferably present in amounts between about 5.0% and 20% by weight based on the ethylene, modifies the polymerization so that more extensible, less dense polymers are produced. The larger amounts of tertiary butyl ethylene within the given range apparently copolymerize with the ethylene.

(DX 14, col. 1, ll. 56-61.)

Phillips relies on the indication of apparent copolymerization because tertiary butyl ethylene is a higher alpha-olefin.

Regardless of what is discloses about tertiary butyl ethylene, Brown does not anticipate the '698 patent. Dr. George A. Mortimer, who Phillips produced at trial to testify on Brown, conceded that there is absolutely no disclosure in the Brown patent that the Brown process resulted in ethylene copolymers with improved impact

strength or stress crack resistance. (Tr. 1777, 1789-93.) Dr. Beasley also testified to the same effect. (Tr. 3649, 3665.) Dr. Mortimer's "toughness and flexibility" testimony (D.I. 257 at 56-57) does not overcome this fundamental deficiency in the Brown disclosure. Once again there is a complete failure of trial proof by Phillips that any ethylene tertiary butyl ethylene copolymer that might be produced in the examples of Brown would inherently possess impact strength or stress crack resistance superior to the lower alpha-olefin propylene and butene copolymers.

Phillips' reliance on Dr. Mortimer's testimony that Brown's apparent copolymers would have densities less than .9300 (D.I. 257 at 57) overlooks the fact that Dr. Mortimer's anticipation opinions were also based on density data for polyethylene prepared without tertiary butyl ethylene which he attempted to read into the Brown disclosure from Franta patent 2,586,322. (DX 38; Tr. 1758-60, 1786-88.) Dr. Mortimer conceded, however, that Brown says nothing about incorporating data from Franta. (Tr. 1760.)

The trial evidence confirmed that there was a sound basis for Brown's uncertainty as to what the tertiary butyl ethylene actually did. Brown disclosed only how much tertiary butyl ethylene was included in the reaction mixture at the start of each run and said nothing about how much tertiary butyl ethylene was incorporated into any copolymers that might have been formed. (DX 14, col. 3, ll. 24-60; Tr. 1785-86.)

The evidence confirms Brown's disclosure that "some other effect, such as chain termination" may have been "predominant." (DX 14, col. 2, ll. 19-26.) Viscosity values

listed in the Table in column 3 of Brown show that as the percent tertiary butyl ethylene in the reaction mixture increases the molecular weight of the resultant polymers decreases substantially. These data show that tertiary butyl ethylene acted as a "telogen" or "chain transfer agent" which lowered molecular weight. (Tr. 57-60; 3655a.) Dr. Mortimer, who has stated that the "chain transfer reaction is more important in ethylene polymerization than it is in the polymerization of almost all other monomers," agreed. (Tr. 1772, 1784.)

Standard Oil's internal report describing the work underlying the Brown patent (PX 628; Tr. 3650-51) confirms that it was not at all clear that any tertiary butyl ethylene had copolymerized. The report states that, in spite of considerable effort, Standard Oil's researchers could not confirm by infrared examination that any tertiary butyl ethylene had actually copolymerized. (PX 628 at A00023; Tr. 3653-54.) The report states (PX 628 at A00023):

> Infrared examination of the structure of the polymers prepared in the presence of the higher concentrations of t-butylethylene has, as previously noted in the case of lower concentrations, failed to confirm the presence of any t-butyl groups. Other methods have also failed to verify the general belief that t-butylethylene participated in the formation of the high polymers but the small decrease observed in polymer density with increasing amounts of t-butylethylene employed (Figure 3) is a strong indication that some copolymerization did occur. There is, however, one property of t-butylethylene about which no uncertainty exists, namely, that it acts as a mild chain terminator. Work reported later in connection with nonolefinic modifiers suggests that this property of t-butylethylene may have been an important factor in its modifying action.

The Standard Oil report also shows that even though Brown's polymers made in the presence of tertiary butyl ethylene had improved extensibility or elongation when compared to polymers made under the same conditions in the absence of tertiary butyl ethylene, the same level of elongation was attained by the Standard Oil researchers using other nonolefinic "modifiers" that would not copolymerize. (PX 628 at A00008, ¶ 1; Tr. 3655, 3665.) There was no evidence that the observed change in extensibility with tertiary butyl ethylene was due to copolymerization. (Tr. 3665.)

The Hogan '721 And '425 Patents

The Hogan '721 and '425 patents are the least pertinent of Phillips' anticipation references. Although Dr. Price and Mr. Hogan testified about these patents at trial, Phillips refers to none of that testimony in its briefs. Indeed, Dr. Price did not attempt to rely on the Hogan patents as disclosing copolymers within the scope of the claims of the '698 patent.

Hogan '721 and '425 relate to processes for making ethylene polymers and copolymers. Phillips implies that these references disclose ethylene higher alpha-olefin copolymers by asserting that "each reference discloses that ethylene and other olefins up to octene may be polymerized by the process and that copolymers of these olefins can likewise be prepared. (D.I. 257 at 58.) The portions of the references Phillips cites relate only to homopolymerization of olefins including higher alpha-olefins (DX 45, col. 1. ll. 52-55; DX 700A at 2, ll. 4-6; DX 44, col. 3, ll. 3-8), copolymerization of ethylene and lower alpha-olefins (propylene and butene), and copolymerization of olefins other than ethylene (DX 45, col. 9, l. 55 to col. 10, l. 21; DX 700A at 14, ll. 1-28; DX 44, col. 3, ll. 8-10).

Dr. Price conceded that there are no examples of ethylene higher alpha-olefin copolymers in either of the Hogan patents (Tr. 1671, 1672, 1674), and there is nothing in either patent which teaches that ethylene higher alpha-olefin copolymers have superior impact strength and stress crack resistance. (Tr. 1675.) The only specific examples of copolymers of ethylene shown in Hogan '721 which are prior art are copolymers of ethylene and propylene. (DX 45, Examples XXI-XXIV.) The specific examples of Hogan '425 disclose only the homopolymerization of ethylene. The only disclosure directed to copolymers is a general statement concerning the possibility of preparing ethylene-propylene copolymers. (DX 44, col. 3, ll. 8-10; Tr. 2341-42.)

The Court finds and concludes that Phillips has not met its burden of proving by clear and convincing evidence that the '698 patent is invalid based on its anticipation defense under 35 U.S.C. §102 by any of the references cited.

C. Phillips' Obviousness Defense

Phillips next contends that the claims of the '698 patent were obvious and therefore the patent is invalid under 35 U.S.C. §103.

The test for obviousness under §103 is whether the invention as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made. The Supreme Court in Graham v. John Deere Co., 383 U.S. 1, 17-18 (1966), held that the resolution of obviousness must be made after a consideration of (1) the scope and content of the prior art, (2) differences between prior art and the claims at issue, (3) the level of ordinary skill in the pertinent art, and (4) objective evidence of

secondary considerations such as commercial success, long felt but unsolved need, failure of others, etc. The Federal Circuit repeatedly has held that "secondary considerations" or "objective indicia of nonobviousness" must always be considered before the determination of obviousness is made. Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 1144 (Fed.Cir. 1985); Simmons Fastener Corp. v. Illinois Tool Works, 739 F.2d 1573, 1574-75 (Fed.Cir. 1984); Jones v. Hardy, 727 F.2d 1524, 1530-31 (Fed.Cir. 1984).

Where a party challenging validity relies on a combination of prior art references to establish obviousness under 35 U.S.C. §103, that party must show that those references contain some teaching which suggests their use in combination. Ashland Oil, Inc. v. Delta Resins & Refractories, 776 F.2d 281, 293 (Fed.Cir. 1985); Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1381 (Fed.Cir. 1986). There must be some reason for the combination other than hindsight gleaned from the disclosure of the patent in suit. Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 1143 (Fed.Cir. 1985); Hodosh v. Block Drug Co., Inc., 786 F.2d 1136, 1143 n.5 (Fed.Cir. 1986); Studiengesellschaft Kohle mbH v. Dart Industries, 549 F.Supp. 716, 736-37 (D.Del. 1982), *aff'd,* 726 F.2d 724 (Fed.Cir. 1984).

Phillips argues, on the basis of Kimberly-Clark v. Johnson & Johnson, 745 F.2d 1437 (Fed.Cir. 1984), that all work which qualifies as Section 102(g) work constitutes "prior art" in a Section 103 obviousness analysis. (D.I. 259 at 62.) The *Kimberly-Clark* holding does not reach that far.

In *Kimberly-Clark,* the work by Champaigne, which the Court found to constitute Section 103 prior art, differs

from the Phillips work in an important respect: the patentee was aware of the Champaigne work, both being employees of Kimberly-Clark (745 F.2d at 1444-45), while the DuPont researchers here were unaware of the Phillips work when the invention of the '698 patent was discovered and made. The Court in *Kimberly-Clark* further observed that an invention which is unknown to both the applicant and the art at the time the applicant makes his invention would constitute secret art (*id.* at 1445-46), and that "the use of such secret art—as § 103 'prior art'—except as required by § 102(e), is not favored for reasons of public policy." (*Id.* at 1446.) Accordingly, the holding of *Kimberly-Clark* is that the work of another under Section 102(g) is prior art under Section 103 only when that work is known to the art or to the patentee before he made the invention. Because Phillips' work was kept secret and was unknown to both the DuPont researchers and the art, it cannot be prior art for purposes of Section 103. However, even if the work of Witt and Leatherman in the mid-1950's may be used as prior art under § 103, then pursuant to § 102(g), that work is only available as prior art to the extent it was not abandoned, suppressed or concealed and thus Phillips is limited to the disclosure of the Witt and Leatherman patent application (PX 88) or its corresponding foreign applications.

1. Scope and Content of the Prior Art

The scope and content of the prior art relied on by Phillips for obviousness include the work of Witt and Leatherman (discussed in Section IV, B.1. above), the seven "anticipation" references (discussed in Section IV, B.2. above), and seven additional patents and publications, viz: the Buckley and Ray article (DX 121), Hagemeyer et al. U.S. Patent 2,899,413 (DX 41), Belgian

Patent 538,782 (DX 106A), Anderson et al. U.S. Patent 2,905,645 (DX 6), the Roedel article (DX 152), the Richards article (DX 151), and the Franta U.S. Patent 2,586,322 (DX 38). The Court now turns to a consideration of these additional references not heretofore discussed under the anticipation references.

Richards, Roedel, Franta, and Buckley and Ray

The art relied on by Phillips concerning free-radical polyethylene and decomposition products of diazo compounds, the Richards article (DX 151), the Roedel article (DX 152), Franta U.S. Patent 2,586,322 (DX 38), and the Buckley and Ray article (DX 121), have little to do with the subject matter of the '698 patent.

The Richards article (DX 151) was published in 1951, years before the discovery of processes for the coordination polymerization of ethylene. Richards teaches that for free-radical polyethylene "[t]o a first approximation the properties of polyethylene may be described in terms of average molecular weight and the degree of crystallinity" (DX 151 at 371), and that it is the presence of adventitious branching which gives free-radical polyethylene its "flexibility and toughness." (DX 151 at top of 374.) Richards teaches that flexibility and toughness may be improved by lowering the crystallinity (or density). (DX 151 at 372.) In other words, if better flexibility and toughness was desired, add more branches. This, of course, is not the invention of the '698 patent. As Dr. Charles Price conceded, there is nothing in Richards about the effect of the length of the branches or side chains (Tr. 1474) and no mention of impact strength or stress crack resistance. (Tr. 1465.) Clearly, it would not be obvious from Richards that longer branches would be

better than shorter branches in producing an ethylene copolymer with superior impact strength and stress crack resistance.

The 1953 Roedel article (DX 152) represents another early attempt to characterize free-radical polyethylene in which mechanisms are proposed to account for the occurrence of long and short chain branching in free-radical polyethylene. For short chain branching, Roedel proposed a branching mechanism and concluded that four carbon branches should be most probable followed by five and three carbon branches. (DX 152 at 6111.) He also noted that it was "probable that two short chains can originate from the same carbon atom." (*id.*) Dr. Beasley, DuPont's principal expert, testified that short chain branching in free-radical polyethylene is more complex than envisioned by Roedel and that things other than the formation of four carbon branches are going on in free-radical polymerization. (Tr. 660, 663, 664-65.) Free-radical polyethylenes may also contain two carbon branches and short chain branches of other lengths, as well as two short chain branches on the same carbon atom. (Tr. 40, 654-55, 665-72.) Only four carbon branches are possible in an ethylene-hexene copolymer, and it is impossible to obtain two such branches on the same carbon atom. Roedel states that "tough" polymers can be made by control of molecular weight and that "flexible" polymers can be made by control of short chain branching. (DX 152 at 6112.) Roedel thus did not teach, as urged by Phillips (D.I. 259 at 8-9, 63-64), that the toughness properties of free-radical polyethylene were due to four carbon branches.

Roedel did not teach, as urged by Phillips (*id.* at 9, 63-64), that long chain branching in free-radical

polyethylene was "deleterious" on flow properties. What Roedel actually states is (DX 152 at 6112):

> Long chain branching, while it has a relatively minor effect on crystallinity because of its low number average, has a marked effect on melt flow and viscoelastic properties.

Dr. Price admitted that Roedel never said that long chain branching in free-radical polyethylene is a bad thing. (Tr. 1718-19.) Thus, Phillips' argument (D.I. 259 at 64) that there was an incentive to reduce long chain branching to obtain good flow properties is a make-weight argument. Dr. Price also conceded that according to Roedel long chain branching has no effect on solid state properties, which would include enviornmental stress crack resistance and impact strength. (Tr. 1717-18.)

DuPont's Franta patent (DX 38) discloses free-radical ethylene polymerization runs at lower temperatures than those normally used in commercial free-radical processes. The resulting polymers, such as Run 22, have higher densities and are more brittle and not as tough as commercial free-radical polyethylenes. (Tr. 3639-42.)

Franta does not suggest that the disclosed polymers had superior impact strength or stress crack resistance. (Tr. 3642.) Dr. Price's admission that he did not know whether the Franta polymers would be more or less tough than commercial free-radical polyethylene (Tr. 1506-07), undercuts Phillips' reliance on the general references in Franta to "improved physical strength" and "superior film, monofil and molding properties." (D.I. 259 at 10.) Stress crack resistance data in the '698 patent for a free-radical polyethylene sample very similar to Franta's Run

22 show that the Run 22 polymer would have very poor stress crack resistance in Igepal—about one hour. (Tr. 3642-47.)

The 1952 Buckley and Ray article discloses materials made from the decomposition of mixtures of diazomethane and 1-diazohexane which, according to Phillips (D.I. 259 at 10-11), would have the same structure as a copolymer of ethylene and heptene-1. Here again there is a complete failure of proof by Phillips that such a copolymer made by decomposition of diazo compounds would inherently possess impact strength or stress crack resistance superior to lower alpha-olefin propylene and butene copolymers.

The Court now assumes that Phillips is not urging the theory initially espoused by Dr. Price that compounds that have the same general chemical structure will have the same properties regardless of how they are made. (Tr. 1192.) Dr. Beasley demonstrated that Price's same structure/same properties theory did not hold true even with simple hydrocarbons, let alone with complex polymers. (Tr. 3665-70; PX 1378, 1379.) When pressed on cross-examination, Dr. Price admitted that in order to give an opinion that one polymer would have the same properties as another he would have to know if it is a copolymer, if it has the same amount of comonomer, if it has the same average molecular weight (or melt index) and the same molecular weight distribution (Tr. 1405-06), and he would have to find out by fractionation and analysis if the comonomer was equally distributed between the high and low molecular weight fractions. (Tr. 1414.) Dr. Price did not have such information for any of the prior art copolymers. Dr. Beasley testified that, if the process parameters are not identical in making two copolymers,

the resultant copolymers will probably have different properties. (Tr. 601, 603-04, 787-88, 813-15, 819, 843-44, 897-921; PX 724, 1257, 1258; DX 592, 593.)

The Buckley and Ray article does not disclose anything concerning impact strength or stress crack resistance. (Tr. 1501-02.) Phillips ignores this fact by arguing that Buckley and Ray taught that longer side chains were more effective for reducing density and improving flexibility than the shorter side chains (D.I. 259 at 66), and that this teaching contradicts DuPont's assertion (D.I. 256 at 11) that, based on experience with free-radical polyethylene, one would increase the number of branch points to improve stress crack resistance and impact toughness. Buckley and Ray did not so teach; the article did report (DX 121 at 3701-02):

> Similar mixed polymers were produced from mixtures of diazomethane and higher aliphatic diazocompounds, up to 1-diazododecane, and the physical properties of these materials depended on both the number and length of the branches introduced into the molecule. Crystallinity was decreased, and solubility increased, either by increasing the proportion of second component or by increasing its chain length. . . .

This passage only refers to the properties of crystallinity and solubility. It says nothing about impact strength or stress crack resistance. The quoted passage teaches that for these mixed polymers in order to lower crystallinity or density one could either increase the number of branches or use branches of increasing length. This simply means that, following the teachings of Buckley and Ray, one would use the same weight percent of different alpha-olefin comonomers to get the same crystallinity or density.

(PX 1301; Tr. 1500.) This, however, is not the unexpected discovery made by DuPont. DuPont's discovery was that a higher alpha-olefin copolymer, such as an octene copolymer, with only half as many branches as a lower alpha-olefin butene copolymer, but with the same level of crystallinity (or density), would unexpectedly have impact strength and stress crack resistance which was superior to the butene copolymer. There is no hint of this unexpected discovery in Buckley and Ray, or in any other reference cited by Phillips.

Anderson '645, Hagemeyer '413, and Belgian '782

The remaining prior art references cited by Phillips are the coordination polymerization processes mentioned in Anderson et al. '645 patent (DX 6), the Hagemeyer et al. '413 patent (DX 41), and the Belgian '782 patent, and are no more pertinent than the Hogan '721 and '425 patents discussed in Section IV, B.2 above. These patents disclose processes for ethylene copolymerization. Anderson et al. '645 (DX 6, col. 4, ll. 3-8), Hagemeyer et al. '413 (DX 41, col. 4, l. 72 to col. 5, l. 4; col. 5, ll. 60-71; col. 10, l. 75 to col. 11, l. 7), and Belgian '782 (DX 106A at L142224). The only examples of ethylene alpha-olefin copolymers contained in those references are of ethylene-propylene copolymers. Example VI of Anderson et al. '645 (DX 6, col. 4, l. 70 to col. 5, l. 20); Example 5 of Hagemeyer et al. '413 (DX 41, col. 10, ll. 25-39); Examples 20-22 of Belgian '782 (DX 106A at L142252-53).

Phillips has offered no explanation why any of these patents would support its obviousness contentions. There are no examples at all in these three references of ethylene higher alpha-olefin copolymers (Tr. 1669-74) and there is

nothing in those references that teaches that superior impact strength or stress crack resistance could be obtained with the higher alpha-olefin copolymers. (Tr. 1675.)

2. *The Level of Ordinary Skill in the Art*

Phillips presented no evidence concerning the level in 1955 of ordinary skill in the art of ethylene polymerization and properties of ethylene polymers. However, Dr. John Beasley's undisputed testimony was that a person of ordinary skill in that art would be someone with (1) a Bachelor's degree in chemistry or chemical engineering plus about 3 years of experience in the field of making and testing polymers, preferably polyethylene, or (2) a Master's degree and two years of such experience, or (3) a Ph.D. degree and one year of such experience. (Tr. 3684-85.) This level of skill is similar to that possessed by such workers as Vandenberg, Hogan, Witt and Leatherman in 1955. (Tr. 3462-69, 2127; PX 1402 at 11-12.)

3. *Differences Between Prior Art and DuPont Invention*

The differences between the prior art and the invention of the '698 patent have been discussed in elaborate detail in Section IV, B.1 and 2, and Section C. The crucial difference between the prior art and the invention of the '698 patent is that there is nothing in any prior art reference that disclosed or even suggests that melt processable ethylene higher alpha-olefin copolymers can achieve superior impact strength and environmental stress crack resistance. There is no hint that this was a possibility, let alone something that would have been obvious at the time to one of ordinary skill in the art. As stated in Section II, A.2 above, the prior art taught that the impact toughness and stress crack resistance properties of ethylene polymers

would decrease if the number of side branches decreased. (Tr. 101-09.) Accordingly, for any given amount by weight of an olefin comonomer, one of ordinary skill in the art prior to the invention of the '698 patent would have expected the impact toughness and stress crack resistance properties of a copolymer to decrease as the number of carbons in the comonomer increased (decrease in number of side branches). DuPont's researchers discovered the opposite. (*Id.*) Furthermore, there is nothing in any of the prior art references which discloses or suggests that the higher alpha-olefin copolymers could have the particular level of Elmendorf tear strength required by claim 1 or the particular level of hoop stress reactance required by claim 12.

Phillips in arguing obviousness jumbles all of its references together without really offering any credible suggestion of how they should or could be combined to suggest the invention of the '698 patent. These numerous and mixed references "skirt all around but do not as a whole suggest the claimed invention, which they must, to overcome the presumed validity." Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1383 (Fed.Cir. 1986).

The prior art discloses that, as of 1955, free-radical polyethylene had been a commercial product since shortly after the end of World War II (Tr. 52-53, 1180), and a new low pressure process for producing linear polyethylene using coordination catalysts had only recently been discovered and was then in the early stages of commercialization. (Tr. 61-62, 1181.)

Researchers at DuPont, Phillips, and elsewhere had made ethylene-propylene copolymers and had found that although they were tougher (due to reduced crystallinity)

than the highly crystalline linear polyethylene, they were no better than or were inferior to comparable commercial free-radical polyethylenes. (Anderson et al. '645 [DX 6]; Hogan '721 [DX 45]; Hagemeyer et al. '413 [DX 41]; Belgian '782 [DX 106A].) Indeed, researchers at Phillips had made (but did not disclose until July 1956) ethylene-butene copolymers that, although tougher than the ethylene-propylene copolymers, were little, if any, better than comparable commercial free-radical polyethylenes. (DX 327, Table VIII at L07779.)

Still others had attempted to make ethylene copolymers with the higher alpha-olefins octene-1 (Vandenberg '963, Example 53 [DX 100]), hexene-1 (Nowlin et al. '649, Example II [DX 77] and Witt), and pentene-1 (Leatherman). However, those attempts resulted in polymers that were either not melt processable, as in the case of Vandenberg and Nowlin, or that they had impact strength inferior to commercial free-radical polyethylenes and to butene and propylene copolymers (Witt and Leatherman).

Thus, the prior art relied on by Phillips taught that one should either make ethylene-butene copolymers or stick with the commercial free-radical polyethylenes.

Phillips' argument (D.I. 259 at 67), that "the same uses disclosed by DuPont were disclosed over and over again in the prior art," overlooks the whole point of the '698 invention. DuPont does not contend that its researchers invented plastic film or plastic pipe. The invention, as clearly disclosed in the '698 patent's specification, was that these copolymers could produce film "with an impact toughness higher than any film forming polyethylene resin ever tested" (PX 1, col. 2, ll. 27-28), or pipe "which, surprisingly, has a longer time to failure

when subjected to internal pressure both at room temperature and at elevated temperatures than does any other pipe forming polyethylene resin ever tested" (PX 1, col. 2, ll. 37-41). Those specifications also disclose that the claimed copolymers when used as wire coatings "surprisingly, have stress crack resistance at least equal to any other wire coating polyethylene resin ever tested" (PX 1, col. 2, ll. 32-34), and, when used for injection molding, produce articles "which, surprisingly, have good impact toughness and stress crack resistances at least equal to any injection moldable resin ever tested" (PX 1, col. 2, ll. 44-47).

That the invention of the '698 patent was not obvious to those of ordinary skill in this art is established by the conduct at the time of real people working in this art. Vandenberg, Nowlin et al., Witt and Leatherman, after they had made ethylene higher alpha-olefin copolymers, failed to anticipate the '698 invention. They simply did not thereafter make the modifications that Phillips now so arduously urges would have been obvious to them.

These actual facts, taken with other contemporaneous and subsequent actions of Phillips' researchers in the mid and later 1950's, including the commercialization by Phillips in 1958 of ethylene-butene copolymers and the belated recognition of the superior properties which can be achieved with the higher alpha-olefins by Kitchen and Hogan after DuPont's Canadian patent (PX 4) issued in 1963, confirm the nonobviousness of the claimed '698 invention.

Phillips argues that the evidence is inadequate to support the conclusion of unexpected superior impact strength and stress crack resistence and is not commensurate with the scope of the claims. (D.I. 259 at 73-

74). In support of this argument, Phillips cites patent application law where the applicant, not the infringer, bears the burden of proof.[15] Moreover, two cases cited by Phillips, *In re* Greenfield, 571 F.2d 1185 (CCPA 1978), and *In re* Lindner, 457 F.2d 506 (CCPA 1972), concerned attempts to overcome obviousness rejections using test data obtained from a single compound where the rejected claims included hundreds of different compounds.

In this case, the evidence includes data for hundreds of different ethylene alpha-olefin copolymers supporting the superior impact strength and stress crack resistance properties of DuPont's invention across the full scope of the claims.[16] Furthermore, any gap may be effectively covered by *trends* discernible by a worker skilled in the art from a large quantity of existing data. *In re* Kollman, 595 F.2d 48, 56 (CCPA 1979). DuPont's researchers discerned these trends from the data available to them at the time DuPont filed its parent and CIP applications for the '698 patent (Tr. 163-65) and the trends they discerned have been firmly established by modern-day computer analyses of that same data. (Tr. 144-66, 845-50, 275-311; PX 1206-11, 1247-52.)

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[15] Only if Phillips had made out a *prima facie* case of obviousness, which the Court finds it has not, would DuPont have any burden with respect to such objective evidence of nonobviousness. Even then, the burden would be that of going forward with such evidence, not the burden of proof on that issue. Ashland Oil, Inc. v. Delta Resins & Refractories, 776 F.2d 281, 291-92 (Fed.Cir. 1985).

[16] This evidence included Elmendorf tear strength and stress crack resistance data presented in the '698 patent (PX 1, Tables I, II, V, VI and VII), all of the ethylene alpha-olefin Elmendorf tear strength and stress crack resistance data in DuPont's possession at the time it filed its CIP application for the '698 patent (PX 1205; Tr. 144-46; DX 884-87), and the comparative data and statements from Phillips, Dow and others in the industry (PX 83, 1215, 34, 72, 133, 10, 1216-21, 1242, 852, 1398). Consequently, at about the time DuPont filed its CIP application for the '698 patent, it had Elmendorf tear strength data for over 400 alpha-olefin copolymers (PX 98; DX 570, 571; PX 1246, 1205; Tr. 144-46, 151).

Phillips advances several arguments attempting to prove this evidence insufficient.

Phillips argues that DuPont's evidence of superior results is insufficient because the "ethylene-butene copolymers are frequently equal to or better than ethylene copolymers of higher olefins" and mentions the butene copolymers currently produced by DuPont's Conoco subsidiary. (D.I. 259 at 71.) In its next paragraph, however, Phillips attempts to have it both ways. Phillips points to an excerpt from the hearing on February 6, 1986 before Judge Schwartz in this case and asserts that DuPont has admitted that one must compare products as they existed at the time, not incorporating 30 years of development work, and that DuPont may not "bootstrap its own work" by relying on the superior properties of Phillips' higher alpha-olefin copolymers. (*Id.*)

The trouble with this argument is that Phillips ignores a fact well understood by the experts (Tr. 601, 603-04) and stated at the hearing before Judge Schwartz—that the only meaningful comparison for determining the effect of comonomer selection is "to make [the polymers] the same way with the same technology." (D.I. 169 at 29.) Phillips did this in its study which began in 1963, after the issuance of DuPont's Canadian patent (PX 83, 1215), and that is what Dow Chemical Company did in its 1979 study (PX 10, 1216-21). The comparison of a butene copolymer with a particular hexene or octene copolymer will not show the effect of carbon chain length on properties unless the processes by which the polymers were made are essentially the same and the densities and melt indices of the respective polymers are comparable. (Tr. 601, 603-04, 787-88, 813-15, 819, 843-44, 897-921; PX 724, 1257, 1258; DX 592, 593; Tr. 2441-47.)

Another argument advanced by Phillips is premised on the testimony of Professor Maxwell—that DuPont "created" the superior properties of the higher alpha-olefin copolymers by skillfully presenting only the most favorable data in its patent applications for the '698 patent. (D.I. 259 at 72-73.) This argument is without merit because the Court has already found that Professor Maxwell's analysis was faulty.

Phillips' reliance on *In re* Boesch, 617 F.2d 272 (CCPA 1980), is not helpful. In that case, the court held that objective evidence comprising the testing of a total of five alloy compositions within the scope of the claims and nine prior art alloy compositions was not sufficient to demonstrate nonobviousness where the claimed alloy compositions overlapped with alloy compositions expressly disclosed in the prior art.

The trouble with Phillips' argument is that it erroneously implies that DuPont's objective evidence is limited to the data contained in the '698 patent, excluding other data in evidence. Phillips has not cited, and the Court is not aware of, any case to support such a limitation.

4. *Commercial Success*

Phillips argues that the higher alpha-olefin copolymers of the '698 patent were not "actually a commercial success" (D.I. 259 at 77-79), that DuPont attempted, but failed, to commercialize higher alpha-olefin copolymers, and that this alleged "failure" confirms the obviousness of DuPont's invention. (*Id.* at 81-82.)

The trial evidence does not support Phillips' argument. DuPont's commercial production of higher alpha-

olefin octene and decene copolymers grew substantially from 1962, the time of their introduction, to 1983, when DuPont's annual production of these copolymers exceeded 210 million pounds. (PX 1282; DX 852.) By the end of 1985, DuPont had produced commercially over 1,800,000,000 pounds. (DX 852.)

Furthermore, Phillips has produced ethylene higher alpha-olefin copolymers in ever increasing amounts since beginning its production of hexene copolymers in 1967. (PX 1264, 1265.) Since DuPont's '698 patent issued in 1978, Phillips has sold over 4,000,000,000 pounds of ethylene-hexene copolymers. (PX 1264.) These sales may be considered as part of the proof of commercial success when determining nonobviousness. Ralston Purina Co. v. Far-Mar-Co, Inc., 586 F.Supp. 1176, 1223 (D. Kan. 1984), *aff'd in part, reversed in part on other grounds,* 772 F.2d 1570 (Fed.Cir. 1985). *Cf.* Parkson Corp. v. Proto Circuits, Inc., 220 USPQ 898, 910-11 (D. Md. 1983).

The trial evidence also shows that many of the major polyethylene producers in the United States are licensed under DuPont's '698 patent and have commercialized higher alpha-olefin copolymers. DuPont's licensees include The Dow Chemical Company (PX 1283), Soltex Polymer Corporation (PX 1284), Mobil Chemical Company (PX 1285), Amoco Corporation (PX 1286), Allied Corporation (PX 1287), Union Carbide Corporation (PX 1288), National Distillers and Chemical Corporation (PX 1290), Norchem, Inc. (PX 1291, 1291A), Exxon Chemical Company (PX 1292), Gulf Oil Corporation (now Chevron) (PX 1293), and American Hoechst Corporation (PX 1294).

Phillips states that "none of the licensees have paid any running royalties and any payment of future running royalties in all licenses under the '698 patent is contingent upon DuPont first obtaining the allowance of claims in the reissue proceeding." (D.I. 259 at 83.) While this is true, Phillips overlooks the fact that under the terms of those licenses, DuPont has received *nonrefundable* down-payments of license fees totaling $2,125,000.00 (*see* Article III(a) of PX 1284-88 and of PX 1290-94, respectively).

Phillips' argument that the economic data does not support a finding of commercial success is not persuasive. For example, Phillips contends that DuPont's commercialization of higher alpha-olefin copolymers was a "failure" because DuPont chose to produce large quantities of ethylene homopolymers and butene copolymers in addition to octene copolymers. (D.I. 259 at 81-82.) The evidence showed otherwise. DuPont's production of ethylene homopolymers and butene copolymers was directed principally to different end-use markets that did not require the superior properties offered by the higher alpha-olefin copolymers. For instance, DuPont produced large quantities of ethylene homopolymers to provide raw materials for its in-house conversion to different value-added products. (Tr. 1091-92, 1133-34; DX 2724.) DuPont's butene copolymer production from its E and J units was completely phased out by 1983. (Tr. 1092, 1098, 1120-21.)

DuPont's butene copolymer production from its K unit began in 1983 as a result of its acquisition of Conoco. Conoco had previously acquired a license to a proprietary polymerization technology that would operate with butene comonomer but not with octene comonomer. (Tr. 1120-

21, 1139.) The butene copolymers from K unit did not compete with the higher alpha-olefin copolymer production from DuPont's E and J units which opened new markets for high molecular weight resins. (Tr. 1121, 1140.)

Phillips argues that there was no commercial success because the sales evidence did not show whether DuPont's octene copolymers obtained a substantial share of the polyethylene market (D.I. 259 at 77), because DuPont's sales of octene copolymers did not surpass the sales of ethylene homopolymers and butene copolymers (*id.* at 77-78), and because DuPont's profitability on its octene copolymers was allegedly "miserable" and a "dog." (*Id.* at 78.) Phillips' analysis ignores the wide acceptance and commercialization of DuPont's invention by the industry, Medtronic, Inc. v. Daig Corp., 789 F.2d 903, 907 (Fed.Cir. 1986), and in particular, the adoption of the invention by Phillips, Parkson Corp. v. Proto Circuits, Inc., 220 USPQ 898, 910 (D.Md. 1983). Furthermore, the reliance of Phillips' expert on the alleged absence of price premiums for the higher alpha-olefin copolymers in a highly competitive industry (D.I. 259 at 78) is not persuasive of a lack of commercial success, particularly when the higher alpha-olefin copolymers of the '698 patent are accepted products and big sellers. Paine, Webber, Jackson & Curtis v. Merrill Lynch, 587 F.Supp. 1112, 1116 (D.Del. 1984).

Phillips next contends that DuPont's production and sales of its octene copolymers experienced "ordinary" growth and that this proves that there is no direct connection or nexus between the merits of DuPont's '698 patent and the commercial success achieved by that invention. (D.I. 259 at 75.) The fact is that DuPont's

ethylene-octene copolymers experienced more than ordinary growth, The evidence proved that DuPont's production of octene copolymers ("Type A") in the ten years following the OPEC oil crisis (1974-1984), increased by 360% from 48,000,000 pounds to 221,000,000 pounds. (DX 2583.) DuPont's production of butene copolymers and ethylene homopolymers increased by only 117% from 170,000,000 pounds to 369,000,000 pounds. (*Id.*) During this same period, the entire plastics industry grew by 58%. Thus, DuPont's ethylene-octene copolymers demonstrated more than "ordinary" growth.

Mr. Edward S. Davis testified at trial that the superior impact strength and stress crack resistance properties of the higher alpha-olefin copolymers enabled DuPont to penetrate several markets that previously employed other polymers or that, through technological advances, required properties superior to those achievable from the butene copolymers. (Tr. 1095-99, 1125; PX 1281.)

Phillips, apparently relying upon the testimony of its economic consultant, Dr. Horace J. DePodwin, argues that DuPont's profitability in its ethylene-octene business was lower than the ordinary profit required at DuPont and lower than the profits achieved by its conventional polyethylene business. (D.I. 259 at 78.) Dr. DePodwin's testimony was based on his determination that DuPont's net return on investment in high density polyethylene resin business should be greater than 20%. (DX 2575.) This testimony is of little weight because Dr. DePodwin obtained his 20% figure from a 1976 DuPont departmental annual report. (Tr. 3387-88.) However, Dr. DePodwin overlooked that the 20% return figure used in the report only applied to "cost-savings projects that have been deferred too long." (DX 2412 at R042837.) Dr.

DePodwin admitted that a single quarterly report concerning the wire and cable end-use market was the only DuPont record of the actual profitability of DuPont's polyethylene business that he reviewed. (Tr. 3444-46.)

On the other hand, Phillips' own actions provide strong evidence that the commercial success of the higher alpha-olefin copolymers is directly attributable to the merits of the invention of the '698 patent. Between 1973 and 1983, Phillips' annual production of butene copolymers dropped from 152 million pounds per year to 60 million pounds per year while its annual production of hexene copolymers grew from 103 million pounds per year to over 850 million pounds per year. (PX 839, 1265.)

Phillips argues that DuPont may not rely on the commercial success that Phillips has experienced in producing and selling higher alpha-olefin copolymers because its sales are the result of process and product developments, cost reductions, technical service and marketing superiority. (D.I. 259 at 76.) The evidence, however, fails to support this argument. What Phillips completely sidesteps is that, despite all of its alleged process and product developments, cost reductions, technical service and marketing achievements, Phillips' personnel concluded in 1980 that—

> Phillips largest volume [5502, 5202] resins as now made will be unacceptable in competition with other resins if butene were used instead of hexene (PX 133, p. 2),

because

> [b]utene does not impart the stress cracking resistance to ethylene copolymers that hexene does (PX 133, p. 1).

This evidence in 1980 flies in the face of Phillips' contention that its commercial success resulted from other factors. It does, however, demonstrate that the market relies upon and demands the superior properties offered by the higher alpha-olefin copolymers of the '698 invention.

Phillips, relying on *In re* Tiffin, 448 F.2d 791 (CCPA 1971), argues that the commercial sales data in evidence is "inadequate" and does not support a finding of nonobviousness because it is "not commensurate with the scope of the claims." (D.I. 259 at 79.) Phillips again relies on patent application cases. The Federal Circuit has repeatedly held in the context of an *issued patent* that,

> The objective evidence of nonobviousness, i.e., the "indicia" of *Graham, supra,* may in a given case be entitled to more weight or less, depending on its nature and its relationship to the merits of the invention. It may be the most pertinent, probative, and revealing evidence available to aid in reaching a conclusion on the obvious/non-obvious issue. It should when present always be considered as an integral part of the analysis.

W. L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1555 (Fed.Cir. 1983). To the same effect is Simmons Fastener Corp. v. Illinois Tool Works, 739 F.2d 1573, 1575 (Fed.Cir. 1984). Thus, the question is not whether the evidence of commercial success is "commensurate in scope with the claims," but rather whether the evidence is relevant to the question of nonobviousness.

The choice by the polyethylene industry to commercialize primarily ethylene-hexene and ethylene-octene

copolymers, but not other higher alpha-olefin copolymers, was essentially a matter of choosing the least expensive alternatives from within the scope of the invention of the '698 patent. (Tr. 71-74, 221.) Hence, the evidence of the commercial success of ethylene-hexene and ethylene-octene copolymers provides "pertinent, probative, and revealing evidence" of the nonobviousness of DuPont's invention.

Finally, Phillips argues that the evidence of commercial success will not support a conclusion of nonobviousness because "economic motivation did not exist to work with higher olefins." (D.I. 259 at 80.)

The pertinent question is whether economic motivation existed to *attempt* to make ethylene polymers having superior impact strength and stress crack resistance properties. The work at both DuPont and Phillips in the 1950's shows that such motivation did exist. To argue, as Phillips does, that higher alpha-olefins were not available in "commercial quantities" is somewhat beside the point. Phillips has offered no evidence to show that such a source of higher alpha-olefins would not have become readily available to Phillips had it discovered early-on the superior properties that can be achieved by the higher alpha-olefin copolymers.

Based on the credible evidence in the light of the criterion set forth in *Graham v. John Deere Co.*, the Court finds and concludes that Phillips has not met its burden of proving by clear and convincing evidence that DuPont's '698 patent was obvious under 35 U.S.C. § 103.

D. Phillips' Indefinite Claims Defense

Phillips contends that the '698 patent is invalid under 35 U.S.C. § 112 (second paragraph) because the claims

are indefinite in that they do not particularly point out and distinctly claim the subject matter which the applicant regards as his patent.

The second paragraph of Section 112 provides, in pertinent part:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

The Federal Circuit has interpreted this to mean that "'[i]f the claims, read in light of the specifications, reasonably apprise those skilled in the art both of the utilization and scope of the invention, and if the language is as precise as the subject matter permits, the courts can demand no more.'" Shatterproof Glass Corp. v. Libbey-Owens Ford Co., 758 F.2d 613, 624 (Fed.Cir. 1985) (quoting Georgia-Pacific Corp. v. United States Plywood Corp., 258 F.2d 124, 136 (2d Cir. 1958)).

1. The Density Limitations

First, Phillips argues that the density limitations of all the asserted claims of the '698 patent are indefinite because the '698 patent does not specify a particular method for preparing the polymer sample for density determination. (D.I. 259 at 86.) This argument is unavailing because there is no evidence in the record to support the proposition that those skilled in the art would use a sample preparation technique other than one involving "reasonably normal fabrication conditions." (DX 327 at L07755; Tr. 2693-94.)

Phillips' own patents, which it contends anticipate the '698 patent, report density values for polyethylenes and ethylene copolymers without reporting how the samples

used for those density determinations were prepared. *See, e.g.,* Witt and Leatherman application (PX 88 at L000017), the Hogan '721 patent at column 36, Table XXVIII and column 38, lines 56-58 (DX 45), and the Nowlin et al. '649 patent (DX 77).

Density values may be influenced somewhat by going to extremes in sample preparation, such as cooling the sample very slowly or subjecting the sample to rapid cooling by a quick quench. (Tr. 359-60.) But, even if samples were prepared by a slow cool or a quick quench technique and were then compared to a sample cooled normally, in most instances, the density differences would not be major. (Tr. 2693-94.)

Phillips also contends that there was no "standard or generally accepted technique" in effect in 1957 for preparing samples for density determination (D.I. 259 at 86), does not help its indefiniteness defense. In Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1385 (Fed.Cir. 1986), the Federal Circuit rejected a similar argument:

> The basis of the district court's holding that the claims are indefinite is that "they do not disclose how infringement may be avoided because antibody affinity cannot be estimated with any consistency." (Conclusion 6.) Even if the district court's finding in support of this holding—that "there is no standard set of experimental conditions which are used to estimate affinities"—is accurate, under the law pertaining to indefiniteness—"if the claims, read in light of the specification, reasonably apprise those skilled in the art both of the utilization and scope of the invention, and if the language is as precise as the subject matter permits, the courts can demand no more." *Shatterproof Glass Corp. v. Libbey-Owens Ford Co.,* 758 F.2d 613, 624 (Fed.Cir. 1985)—the claims

> clearly are definite. The evidence of record indisputably shows that calculating affinity was known in the art at the time of filing, and notwithstanding the fact that those calculations are not precise, or "standard," the claims, read in light of the specification, reasonably apprise those skilled in the art and are as precise as the subject matter permits. As a matter of law, no court can demand more.

See also W. L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1558 (Fed.Cir. 1983), where the court rejected the argument that the absence of a definition for "specific gravity of the solid polymer" rendered the specification non-enabling and the claims indefinite.

The short answer to Phillips' contention of indefiniteness is demonstrated by the ease with which Phillips' expert witnesses applied at trial the density limitations of the '698 claims to the prior art references. (Tr. 1318, 1320, 1322-26, 1329-30, 1332, 1338-39.) Rosemount, Inc. v. Beckman Instruments, Inc., 727 F.2d 1540, 1547 (Fed.Cir. 1984).

2. Elmendorf Tear Strength Limitation of Claim 1

Claim 1 of the '698 patent contains an Elmendorf tear strength limitation of 150 to 400 grams per mil. (PX 1, col. 13, ll. 16-25.) Phillips makes three arguments that this limitation is indefinite because one skilled in the art (a) would not know how to perform the test on plastics, (b) would not know how the Elmendorf tear strength specimen should be prepared, and (c) the thickness of the tear strength specimen is not specified. (D.I. 259 at 87-88.)

While it is true that the Elmendorf tear strength test for paper was not an ASTM standard for plastic film in 1956-57, it was a recognized test that was used at that time

on plastic film by those skilled in the art. This is shown, for example, by Phillips' September 1956 "Plastic Test Manual," which contained "[o]nly those tests most frequently used" on plastics in Phillips' laboratories (DX 706 at L142656), specifically included an adaption for plastic film of the ASTM Elmendorf tear strength paper test —D689. (DX 706 at L142733-34; Tr. 2360-64.) Professor Maxwell's testimony to the contrary is not credible (Tr. 1851-53) because he admitted on cross-examination that he had heard that the Elmendorf tear test was being used to evaluate toughness of plastics in 1956-1957 (Tr. 1939) and that he had no real hands-on experience with the Elmendorf tear strength test. (Tr. 1940-41.)

Phillips' contention that the '698 patent does not show how the Elmendorf tear strength specimen should be prepared is also without merit. The DuPont patent clearly indicates that the Elmendorf tear strength data reported were obtained on compression molded films. (Tr. 890-91.) That was a technique generally being used at the time for Elmendorf tear strength measurements, especially for laboratory purposes on small quantities of material. (Tr. 742-43.) Furthermore, the evidence established that one skilled in the art would have used compression molded samples of an appropriate thickness such as 10-12 mils. (Tr. 755-56, 1000.) Dr. Beasley explained that it was important to keep the film thickness within a relatively narrow range in order to obtain the best results using the Elmendorf tear test. (Tr. 756, 763-64, 1000.) Compression molded films are normally molded within a relatively narrow range of thickness (such as 10-12 mils) for the Elmendorf tear strength test because it is difficult to compression mold extremely thin films and because thick films would not tear in the testing device. (Tr. 764.) If the mold was properly filled prior to molding by

distributing the polymer uniformly throughout the chase (Tr. 2027), orientation in the resultant film would be minimized. (Tr. 745-53.) But in the samples prepared by Professor Maxwell, he failed to do this. The fact that his demonstration sheet of compression molded film (DX 872A) was roughly twice as thick in the center than it was in the corners (Tr. 2028-30) indicated that he did not fill the mold properly. He also did not allow the polymer to melt before applying pressure in the compression molding process (Tr. 1990), which is contrary to normal practice for compression molding. (Tr. 1026; DX 706 at L142658, Item (4)(Phillips 1956 compression molding procedure); DX 547 (ASTM D 1928-70, procedure C, ¶ 15.9 at L135721)).

Finally, Phillips' contention that one skilled in the art would not know what thickness to prepare the Elmendorf tear strength specimens is likewise untenable. The credible evidence indicated that the normal range of compression molded film thickness would be in the range of 10 to 12 mils and that any variations of thickness would have little effect on Elmendorf tear strength (Tr. 1000), *see* handwritten comment (on DX 691, a DuPont letter) which states:

> Elmendorf values are ok for thin films but as they get too thick the value depends on thickness. It is to be assumed that a skilled analyst would use a thin enough film (Tr. 999-1000).

3. The X-Ray Crystallinity Limitation of Claim 5

Phillips argues that Claim 5 which contains a 40-70% crystallinity limitation as measured by X-ray diffraction makes that claim and its dependent claims 10, 12, and 14 indefinite because X-ray crystallinity measurements are not standard and vary widely between laboratories. Yet,

the evidence indicated that one skilled in the art would recognize X-ray crystallinity as a qualitative indication of comonomer content and would take into account the plus or minus 10 or 20 percent laboratory to laboratory variance inherent in the technique (Tr. 1041) in applying the X-ray crystallinity limitation to Claim 5 and its dependent claims. The evidence showed that determining X-ray crystallinity was known in the art at the time of filing the '698 patent application and notwithstanding that those calculations are not precise or standard, Claim 5, read in the light of the specifications, reasonably apprised those skilled in the art and are as precise as the subject matter permits. Hybritech, Inc. v. Monoclonal Antibodies, Inc., *supra,* 802 F.2d at 1385 (Fed.Cir. 1985).

The Court concludes that based on the credible evidence presented, Phillips has not borne its burden of proving by clear and convincing evidence that the claims of the '698 patent are invalid for indefiniteness under the second paragraph of 35 U.S.C. § 112.

V. UNENFORCEABILITY

Phillips charges that DuPont committed three separate acts of inequitable conduct when prosecuting the '698 patent before the Patent Office and that any one of those acts alone is sufficient to declare all the patent claims unenforceable.

Phillips, of course, by asserting its unenforceability defense, bears the heavy burden of proving by clear and convincing evidence that the nondisclosed or false information was material to the decision of the Patent Office in issuing the patent. J.P. Stevens & Co., Inc. v. Lex Tex Ltd. Inc., 747 F.2d 1553, 1559-62 (Fed.Cir. 1984); Environmental Designs v. Union Oil Co. of Cal., 713 F.2d 693, 698 (Fed.Cir. 1983).

The three acts of inequitable conduct which Phillips contends DuPont committed may be summarized as follows: (1) when the prosecution of the '698 patent was recommenced after its interruption by Interference No. 94,730, DuPont failed to disclose to the patent examiner that the Baxter ethylene-styrene work upon which DuPont relied to overcome the prior art of the Anderson et al. '645 patent had been rejected by the Court of Customs and Patent Appeals ("CCPA") in the '730 Interference; (2) DuPont improperly selected data which it presented to the Patent Office to support its argument that the claimed copolymers possess unexpectedly improved properties; and (3) DuPont failed to disclose to the Patent Office Phillips' Belgian Patent 535,082, a material reference known to DuPont. The Court will consider these contentions in order.

A. Failure To Disclose CCPA's Opinion In Interference No. 94,730

The record before the Patent Office shows that the patent examiner in the first office action rejected all the original claims of the CIP application, which lead to the '698 patent, for lack of invention in view of a number of cited references. (PX 3 at 000022-23.) To overcome the examiner's rejections, DuPont relied upon ethylene-styrene copolymerization performed by Warren Baxter which was presented in a Rule 131 affidavit. (PX 3 at 000026-31, 000101, 000108-112.) The examiner again rejected the claims as unpatentable over Anderson et al. '645 and ruled that DuPont's affidavits were insufficient to show reduction to practice because of a complete failure to establish utility. (PX 3 at 000113-14.) The Board of Appeals reversed the examiner and held that DuPont's affidavit of December 22, 1959, was sufficient to overcome the Anderson et al. '645 patent. (PX 3 at 000262-266.)

Following this decision, Patent Examiner J. L. Schofer allowed all claims but formal allowance was withheld pending a study of interference questions. (PX 3 at 000267.)

Prosecution of the '698 patent application was discontinued pending the outcome of Interference No. 94,730, declared between DuPont (as assignee of Drs. Anderson and Stamatoff), and applications of Ziegler et al. and Natta et al. (DX 915.) Following the proceedings before the Board of Patent Interferences, the Board held that the Baxter ethylene-styrene copolymer had not been proved by contemporaneous documents to have been of any practical utility. (DX 487-D at 158-66.) The Court of Customs and Patent Appeals agreed with the Board of Interferences' decision that the Baxter copolymer runs in 1954, relied upon by Anderson, had not established practical utility and thus Anderson was not entitled to a priority date earlier than the June 8, 1955 priority date which the CCPA awarded to Natta over Ziegler. Anderson v. Natta, 480 F.2d 1392, 1395-97 (CCPA 1973). (DX 487-E at 1395-97.)

Upon resumption of the prosecution of the patent application after the interference decision in 1973, the patent examiner in charge of the application for the '698 patent on December 10, 1973, rejected all claims as obvious either based on the disclosures of the other parties in interference or in view of Anderson et al. '645 and further stated, assuming unobviousness, DuPont's affidavits did not antedate Anderson. (PX 1352 at 000689-691.)

After obtaining an extension of time, DuPont responded on April 18, 1974, to the examiner's rejection on December 10, 1973, of all claims of the application. (PX

3 at 000291-302.) It is in this response that Phillips contends DuPont misled the examiner because DuPont again argued, among other things, that the prior art, including Anderson et al. '645 on which the examiner relied in rejecting certain of the claims in December 1973 (PX 3 at 000113-14), had been overcome by the decision of the Board of Appeals without further disclosing to the examiner that the Board of Appeals' decision had been rejected by the Board of Interferences and concurred in on appeal by the CCPA.

If these recited facts were the only matters of record in the Patent Office, Phillips' unenforceability defense might have merit. There are, however, other relevant facts which in fairness must be considered. The crux of Phillips' charge on this misrepresentation or failure to disclose is premised on the assumption that the patent examiner responsible for the '698 patent application was unaware of the decision in interference that no utility had been shown for the Baxter ethylene-styrene copolymer in DuPont's Rule 131 affidavit submitted prior to the interference. The record, however, shows just the opposite. The patent examiner in charge of the '698 patent application was J. L. Shofer and he was fully aware of DuPont's Rule 131 affidavit and the ethylene-styrene work disclosed in it because in 1962 he prepared a brief for the Board of Patent Appeals in which he specifically discussed the affidavit and work. (PX 3 at 000247-52; Tr. 3098-99.) Mr. Shofer was also aware of the interference proceedings (PX 3 at 000267) and continued as examiner in charge when prosecution resumed after the interference. (PX 1352; Tr. 3114, 3116-17.) It seems certain that when Phillips developed this ground for unenforceability, it erroneously believed that Mr. Shofer was not the examiner who resumed the prosecution of the application. This

is shown quite clearly by Phillips' argument made May 28, 1986, shortly before the beginning of the trial of this case. Phillips incorrectly believed the examiner was a Mr. Holler. (D.I. 208 at 14-16.)

Not only does the factual evidence before the Court establish that Mr. Shofer as the examiner in charge was fully aware of the interference proceedings but to find otherwise this Court would have to assume that Mr. Shofer was either incompetent or refused to follow Patent Office regulations in effect in 1973. Those regulations required that (1) the interference record was to be returned to the examiner "as soon as the decision or judgment has become final," (2) the examiner was to "examine" the interference judgment "to determine the basis therefor" and act on the pending applications of the losing parties "at once," and (3) the examiner was to "make an entry on the index in the interference file . . . that the decision has been noted . . . and initialed by him."[17]

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[17] When the interference proceeding was concluded in 1973, § 1107 of the Manual of Patent Examining Procedure ("MPEP") (PX 612) required that "the interference is returned with the entire record to the examiner as soon as the decision or judgment has become final." MPEP § 1109.02 (PX 613) required that:

> The application of each of the losing parties following an interference terminated by a judgment of priority is acted on at once. The judgment is examined to determine the basis therefor and action is taken accordingly.

The examiner was required to take specific notice of the decision in the interference under MPEP § 1107 (PX 612):

> After the files have been returned to the examining group the primary examiner is required to make an entry on the index in the interference file on the next vacant line that the decision has been noted, such as by the words "Decision Noted" and initialed by him. The interference file is returned to the Service Branch of the Board of Patent Interferences when the examiner is through with it. There it will be checked to see that such note has been made and initialed before filing away the interference record.

The evidence established that Examiner Shofer complied with these requirements. In the index to Interference 94,730, the notation "Decision Noted JLS" appears following notations regarding the decision of the Court of Customs and Patent Appeals in Interference 94,730. (PX 1353 at 1408.)

When Mr. Thomas J. McPeak, Phillips' patent law expert, was confronted by these facts, he simply stated that it was conceivable that "Examiner Shofer did nothing more than his minimum duty of making the entry that he was aware of the adverse award of priority and then shipped the file back to the Interference Branch without carefully studying and without informing himself of the effect of the Board of Appeals and CCPA's decision . . . ." (Tr. 3139.) The Court will not speculate that either Mr. Shofer was incompetent or that he deliberately refused to follow express regulations of the Patent Office.

The fact clearly appears that Examiner Shofer reinstated the Anderson et al. '645 patent as a reference on December 10, 1973 (PX 1352 at 000689-90) after he had noted the CCPA decision on October 23, 1973 (PX 1353 at 1408) and this action fully confirmed the fact that he was aware of the CCPA holding of no utility for the ethylene-styrene work. The Court is not convinced by the credible evidence that Examiner Shofer was deceived by DuPont.

Furthermore, as previously found, when prosecution was resumed after the interference in December 1973, Anderson et al. '645 was cited against the process claims then pending, viz. claims 2 and 3. (PX 1352 at F000690.) Anderson et al. '645 was *not* cited against copolymer product claims, viz. claims 5 through 20. (*Id.* at F000691.) Those claims were rejected by the Examiner on

the basis of the disclosures of the adverse parties in the interference (Natta and Ziegler). (*Id.*) DuPont in responding to the examiner's action did not rely on the prior ethylene-styrene work to distinguish the process claims from Anderson et al. '645 because DuPont cancelled those claims.[18] (PX 3 at 000291.)

In arguing patentability of the copolymer product claims 5 through 20, DuPont distinguished the references that had been cited (the Natta and Ziegler interference disclosures) by pointing out that the product claims were limited to copolymers of ethylene and higher alpha-olefins having 5 or more carbon atoms and that Ziegler and Natta did not disclose such copolymers, or the improved properties that they achieve:

> Thus the situation is that neither Ziegler et al. nor Natta et al. had any disclosure on which to base a composition count for interference purposes, nor any disclosures from which one might surmise that there would be any advantage in obtaining such copolymers.

(PX 3 at 000297-98.)

DuPont specifically relied on the "very high film strength and impact resistance measured, for instance, by high Elmendorf tear strength values and by remarkable environmental stress-crack resistance" of the claimed copolymers. (PX 3 at 000298.)

B. Manipulating Data Submitted To Patent Office

Phillips' second charge of inequitable conduct is that DuPont improperly selected data to show unexpected improvement in Elmendorf tear strength and environmental stress crack resistance of ethylene copolymers with

[18] The "count" in the interference on which priority had been awarded to Natta was a process claim. (Tr. 3100-01.)

higher alpha-olefins as compared with ethylene-propylene and ethylene-butene copolymers. Thus, because the Patent Office has no facilities to check the data, Phillips says DuPont took unfair advantage by impermissively selecting data to cast the reported results in a favorable light. (D.I. 259 at 95.)

This charge is based on the direct testimony of Professor Bryce Maxwell who testified that he made an analysis of all the data available to DuPont and found a trend of decreasing Elmendorf tear strength or no trend at all. (DX 874; Tr. 1873-74, 1892-93.) Professor Maxwell's analysis of DuPont's data on environmental stress crack resistance, according to his direct testimony, showed no improvement of those properties of ethylene higher alpha-olefin copolymers as compared to ethylene-propylene and ethylene-butene copolymers. (Tr. 1904-05; DX 884, 887.)

The Court finds that Professor Maxwell's analysis of the DuPont data was blemished and faulty. Professor Maxwell's opinion on Elmendorf tear strength was based cn a chart which plotted for each comonomers DuPont used, the minimum, maximum, and average tear strength. (DX 874.) This chart did not take into consideration two key parameters, melt index and density. The two hands-on experts who testified in this case, Dr. Beasley for DuPont and Mr. Hogan of Phillips, agreed that comparisons should not be made in this manner. Because of the significant effect that melt index and density have on properties such as impact strength and stress crack resistance, samples with comparable melt indices and densities should be compared to determine the effect that the type of comonomer has on properties. (Tr. 601; 2441-47.)

Professor Maxwell, however, failed to do this. He "never looked at the melt index" and "never looked at the density." (Tr. 2019.) He simply took the data and "threw it all together" regardless of melt index and density. (Tr. 2010.)

Professor Maxwell's testimony on cross confirmed that his "mish-mash" approach to analyzing the data (Tr. 2010) was totally unsound. He conceded that "melt index is probably one of the most important terms in the field of polymers, particularly in the field of polyolefins" and that going from 0.2 up to 15 in melt index "would make quite a difference." (Tr. 2007, 2021.) As for density, he said, "Density is a very important property to every material. It's even more important in polyolefins, because density changes with the processing of the material." (Tr. 2007.)

Professor Maxwell also conceded that in teaching his students, he would instruct them about the effect that melt index and density have on properties such as impact strength. (Tr. 2004.) Yet, he failed to explain why his testimony here on direct examination omitted what he would tell his students about melt index and density.

On the other hand, DuPont, analyzing the tear strength data for the Court, took both melt index and density into account. DuPont prepared computer generated surfaces and contour plots which show how the Elmendorf tear strength varied with density, melt index and the number of carbon atoms in the alpha-olefin comonomer used. (PX 1206, 1207, 1208, 1209, 1210, and 1211.)[19] These charts establish that at a given density and

[19] Mr. Paul Boeke, who was the manager of Phillips' analytical laboratory in the 1950's, has endorsed the usefulness of surface plots like these to depict the effect of multiple parameters on polymer properties. (Tr. 2664; PX 1332.)

melt index, the higher alpha olefins give better Elmendorf tear strength. (Tr. 163-66.)

When Professor Maxwell was confronted with these charts on cross-examination, he conceded that he would say "bravo" to any of his students who would analyze the data in this manner.

> I would say bravo because it shows that he has a high respect to density. He has a high respect to melt index.
>
> Now, I personally believe he caught that from me. I would emphasize that the term melt index is probably one of the most important terms in the field of polymers, particularly, in the field of polyolefins. Density is a very important property to every material. It's even more important in polyolefins, because density changes with the processing of the material.

(Tr. 2007.)

When asked what he would say to a student who would analyze the data without considering the effect of melt index or density as Phillips had done in DX 874, Professor Maxwell gave the excuse that no one at Phillips had asked him to take those parameters into account.[20] (Tr. 2010-11.)

In like manner, when Professor Maxwell analyzed DuPont's stress crack data, he did not take melt index and density into account. (Tr. 2037, 2040.) Again his analysis was defective. For example, the free-radical polyethylene samples that Phillips listed in its stress crack data summaries (DX 884 to 887) had densities in the range of .91 to .92. The densities of the ethylene alpha-olefin copolymers, however, were significantly higher, .93 to .95. (Tr.

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[20] Phillips also failed to take melt index and density into account in the other tear strength charts Professor Maxwell relied on at trial. (DX 875, 876, 877, 879, 880, 881, 882, and 883; Tr. 2018-19.)

2035-37.) This difference in densities was significant because increasing density reduces stress crack resistance. (Tr. 95-96.) Professor Maxwell conceded that if the DuPont researchers had analyzed the data the way he did, they never would have made the invention on which the higher alpha-olefin ethylene copolymer industry is based. (Tr. 2043-44.)

Finally, Phillips in its post-trial brief advanced a different and entirely new contention (D.I. 259 at 99-100) of DuPont's inequitable conduct based on a document (DX 692) which was introduced into evidence for the limited purpose of buttressing Professor Maxwell's testimony. (Tr. 3576-79.) DX 692 is an undated draft CIP application which Phillips now uses for an entirely new contention not developed at trial that persons who prepared the CIP application had unfavorable data on ethylene copolymers with tetradecene (14 carbons) and octadecene (18 carbons) specifically before them in the draft of that application and deliberately deleted that data and substituted favorable data on such copolymers to mislead the Patent Office. (D.I. 259 at 99-100.)

DuPont strenuously objects to the use of this draft CIP application to make a new unenforceability contention that Phillips never before advanced. Since Phillips never commented upon this document at trial and DuPont had no opportunity at trial to offer testimony or documentary evidence to rebut this new argument, the Court will sustain DuPont's objections and will not consider this argument raised for the first time in post-trial briefing.[21] Every opportunity was given to Phillips at trial to raise all

[21] DuPont attached to its brief (D.I. 261, Ex. 1 through 8) documents which it states it would have offered at trial, along with testimony, if Phillips had used this document for the contention now being made. The Court will not at this late date consider those documents since DuPont's objection to D.I. 692 has been sustained.

the issues it desired, but it did not raise this issue of fraud and it now comes too late. Laitram Corp. v. Cambridge Wire Cloth Co., 785 F.2d 292, 295 (Fed.Cir. 1986).

C. Belgian Patent 535,082

At the close of its case, Phillips offered a group of documents by DX number about which it had said nothing at trial through testimony or even argument. When asked by DuPont's Attorney if any of the documents related to another fraud charge, Phillips' counsel represented that there was "nothing new and different" and that the additional documents would be used to "buttress" Mr. McPeak's testimony regarding the prosecution of the '698 application after the interference and Professor Maxwell's testimony regarding the presentation of data in the application (Tr. 3577-79.)

Despite Phillips' representation at trial, it now for the first time in its post-trial brief advances the unenforceability argument that the Belgian '082 patent (DX 87) was a material prior art reference[22] known to DuPont which DuPont intentionally failed to disclose to the Patent Office. (D.I. 259 at 101-04.) The Court will not at this late date after trial consider this third fraud charge of Phillips.

The trial of a patent case of this nature and magnitude is difficult enough for a District Judge even when he is presented at trial with expert and other testimony clarifying the issues. It becomes impossible to decide an issue after trial has ended, particularly a fraud contention advanced and developed in a testimonial vacuum. Booby-trapping an adversary by this technique cannot be condoned. DuPont had no opportunity at trial to call

[22] Phillips' counsel also represented that DX 87 (the Belgian '082 patent) was not being offered as prior art. (Tr. 3576.)

witnesses or develop evidence to rebut this new and different fraud theory. In the absence of such trial testimony, the Court refuses at this stage to resolve the charge in an *ex parte* manner. Laitram Corp. v. Cambridge Wire Cloth Co., 785 F.2d 293, 295 (Fed.Cir. 1986); *see* Studiengesellschaft v. Dart Industries, 726 F.2d 724, 727-28 (Fed.Cir. 1984).

The Court concludes that Phillips has not met its burden of proving by clear and convincing evidence that the '698 patent is unenforceable.

VI. INFRINGEMENT

A. General Legal Principles

Having found and concluded that Phillips has not proved by clear and convincing evidence that DuPont's '698 patent is invalid or nonenforceable for any of the reasons cited, the Court turns to the issue of infringement.

DuPont has the burden of proving infringement by a preponderance of the evidence. Hughes Aircraft Co. v. United States, 717 F.2d 1351, 1361 (Fed.Cir. 1983). This applies to both literal infringement and infringement under the doctrine of equivalents. *Id.*

The threshold question concerning infringement is that of claim interpretation or claim construction. Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 866 (Fed.Cir. 1985). Claims must be construed in light of the specification of the patent as they would be by those of ordinary skill in the art. Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 867 (Fed.Cir. 1985); Fromson v. Advance Offset Plate, Inc., 720 F.2d 1565, 1571 (Fed.Cir. 1983).

As the Court held in Section II, A.2 above, limitations which are essential to the invention, but not explicitly

stated in the claims, are read into the claims from the specification to distinguish the invention from the prior art. United States v. Adams, 383 U.S. 39 (1966); Roberts Dairy Co. v. United States, 530 F.2d 1342 (Ct.Cl. 1976); Stanley Works v. McKinney Mfg. Co., 520 F.Supp. 1101 (D.Del. 1981).

Following the claim construction step, the question of literal infringement then becomes whether the claims, as properly interpreted, read on the accused products. Loctite Corp. v. Ultraseal Ltd., *supra,* 781 F.2d at 866 (Fed.Cir. 1985). If the claims read on the accused products that is the end of the infringement inquiry.

However, a product that does not literally infringe a claim may infringe under the doctrine of equivalents. This doctrine protects a patentee from an infringer who appropriates the invention but avoids the literal language of the claims. If the accused product and the claimed invention perform substantially the same function in substantially the same way to give substantially the same result, the product infringes under the doctrine of equivalents. Graver Mfg. Co. v. Linde Co., 339 U.S. 605, 608-09 (1950); Martin V. Barber, 755 F.2d 1564, 1567 (Fed.Cir. 1985); *see* Great Northern Corp. v. Davis Core & Pad Co., Inc., 782 F.2d 159, 166 (Fed.Cir. 1986). In determining infringement under the doctrine of equivalents, it is appropriate for the Court to determine what is the "heart" or "essence" of the claimed invention, and to then determine whether the accused product uses the "heart of the invention." Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 875 (Fed.Cir. 1985); Atlas Powder Co. v. E. I. du Pont de Nemours, 750 F.2d 1569, 1582 (Fed.Cir. 1984).

The question of equivalence is determined as of the time infringement takes place, not when the patent appli-

cation is filed or when the patent issues. Atlas Powder Co. v. E. I. du Pont de Nemours, 750 F.2d 1569, 1581 (Fed.Cir. 1984). Consequently, an accused product that is "an improvement" over the claimed invention as a consequence of advances developed subsequent to the patent can be held to infringe under the doctrine of equivalents. Datascope Corp. v. SMEC, Inc., 776 F.2d 320, 326 (Fed.Cir. 1985); Atlas Powder Co. v. E. I. du Pont de Nemours, 750 F.2d 1569, 1581 (Fed.Cir. 1984); Hughes Aircraft Co. v. United States, 717 F.2d 1351, 1365 (Fed.Cir. 1983).

B. The Claims of '698 Patent

As previously held in Section II, A.2, the invention of the '698 patent is the discovery that melt processable copolymers of ethylene and higher alpha-olefins having five or more carbon atoms unexpectedly can achieve impact strength or environmental stress crack resistance properties that are superior to those obtained with free-radical polyethylene, with linear polyethylene and with comparable copolymers of ethylene and the lower alpha-olefins propylene (3 carbons) and butene (4 carbons). The asserted claims of the '698 patent, claims 1, 2, 5, 10, 12, and 14 read as follows (PX 1):

> 1. An interpolymer composed of interpolymerized comonomers consisting essentially of ethylene and at least one normal aliphatic mono-alpha-olefinic hydrocarbon containing from 5 to 10 carbon atoms per molecule, the proportion of said monoolefinic hydrocarbon being from 3 to 7% of the weight of the interpolymer, said interpolymer having a melt index within the range of 0.3 to 20, and, when in the form of a film, an Elmendorf tear strength in the range of 150 to 400 grams per mil, and a density of 0.93 to 0.94.

2. An interpolymer of ethylene and from 1% to 20% by weight of a higher olefinic hydrocarbon having 5 to 18 carbon atoms per molecule, said higher olefinic hydrocarbon having no non-aromatic unsaturation other than one terminal $-CH=CH_2$ per molecule, said interpolymer having essentially no other copolymerized components, the proportion of the interpolymerized ethylene component therein being not less than 80% nor more than 99% by weight, the percentage crystallinity of the interpolymer being such that the density ranges from 0.95 to 1% interpolymerized higher olefinic hydrocarbon down to 0.9 at 20% interpolymerized higher olefinic hydrocarbon.

5. An interpolymer of ethylene and a higher olefinic hydrocarbon having 5 to 10 carbon atoms per molecule, said higher olefinic hydrocarbon having one terminal $-CH=CH_2$ per molecule and no other olefinic unsaturation, said interpolymer being further characterized in that it has a X-ray crystallinity in the range of 40 to 70%, a melt index in the range of 0.3 to 20, a density in the range of 0.9 to 0.95 and said interpolymer being further characterized in that its density is not less than 0.93 unless the content of said higher olefinic hydrocarbon in the interpolymer is at least 3% by weight.

10. Composition of claim 5 in the form of a film.

12. Composition of claim 5 in the form of pipe which is further characterized by withstanding 3000 hours at hoop stress of 750 psi and a temperature of 60°C.

14. A composition of claim 5 having a density in the range of 0.910 to 0.945 and a melt index in the range of 0.3 to 2.1.

At trial, the evidence relating to infringement was presented by DuPont in summary exhibits and charts.[23] Following this method, the Court will summarize the evidence that establishes that Phillips products at issue meet all the elements of the asserted claims, including those elements which must be read into the claims in the light of the specifications. Tables for summarizing the evidence for Phillips' individual copolymers are attached at the end of this opinion in Appendix I.

C. Infringement of the '698 Claims

1. Type of Comonomer

Each of the accused Phillips copolymers is a copolymer of ethylene and hexene-1 which is a comonomer within the scope of the asserted claims of the '698 patent. Hexene-1 is a "normal aliphatic mono-alpha-olefinic hydrocarbon containing from 5 to 10 carbon atoms per molecule." (PX 1, claim 1, col. 13, ll. 18-20.) Hexene-1 is a "higher olefinic hydrocarbon having no nonaromatic unsaturation other than one terminal $-CH=CH_2$ per molecule and no other olefinic unsaturation." (PX 1, claim 5, col. 14, ll. 3-7.) Hexene-1 is within the literal scope of the comonomers claimed in claims 1, 2 and 5 (as well as in the dependent asserted claims, claims 10, 12 and 14).

2. Melt Index

Melt index is a measure of the rate at which a polymer flows when melted and it relates to the melt

[23] These summary exhibits include PX 1231, 1235, 1235A, 1235B, 1236, 1237, 1237A, 1238, 1238A, 1239, 1376; DX 2704, 2656A, and charts PX 1230, 1245, and PX 1365 to 1369.

processability of the material.[24] The copolymers of the '698 patent have melt indices "in the conventional melt processable range" so that they may be processed in conventional melt fabricating equipment. (Tr. 87-88.) The patent specifically states that "they have melt indexes in the range of 0.2 to 20" to enable them "to be fabricated by conventional fabricating techniques." (PX 1, col. 4, ll. 12-15.) Dr. Price read the '698 patent as having an 0.2 melt index limitation. (PX 1303A; Tr. 1545.)

In order to be melt processable by the conventional techniques used when the applications were filed, a lower limit melt index of 0.2 is required. (Tr. 88, 325.) Mr. Hogan of Phillips agreed that the lower limit of the "processable melt index range" was about 0.2 melt index. (Tr. 2420-21.)

Dr. Beasley testified that he placed great reliance on melt index (Tr. 358, 365), and for that reason, he concluded that Phillips' hexene-1 copolymers with melt indices significantly below 0.2 would not infringe the claims of the '698 patent. (Tr. 329.)[25]

Claims 1 and 5 of the '698 patent have specific melt index ranges of 0.3 to 20. (PX 1.) Claim 14 specifies a narrower range for melt index of 0.3 to 2.1. (PX 1.) Claim 2, when read in light of the specification of the '698 patent, is limited to a melt index range of 0.2 to 20. (Tr. 88, 325, 329, 359.)

[24] The melt index test measures how much polymer will flow through a capillary tube of a specified size at a specific pressure governed by the weight used (2160 grams) and temperature (190°C.). (Tr. 42, 358, 1021-22; PX 6, 657.) The result of the melt index test is expressed in grams per 10 minutes.

[25] As a consequence of this testimony, DuPont withdrew its charge of infringement as to eleven products—HXM 47100, HXM 50100, HXM 50100-01, HXM 50100-02, HXB 50130 (or M-545), ER9-0001, ER9-0002, ER9-0020, M-449, M-564, and M-550. (Tr. 324-29.)

No dispute exists as to the melt index values of the ethylene-hexene-1 copolymers accused of infringement since almost all of the data relied upon by DuPont are Phillips' own melt index values from product brochures or internal product specifications. (*See* Appendix I attached.)

Some of the Phillips melt index data are the melt index of the hexene-1 copolymers in the form of fluff. In some reactors, the polymer is produced in the form of small particles called fluff, which are inconvenient to ship due to a lower bulk density and are not in the form that resin purchasers desire. (Tr. 369.) Consequently, the fluff product is fed through an extruder and made into pellets. The pellets are more compact and are easier to handle and ship. (*Id.*) The extrusion or pelletizing process causes a decrease in the melt index of the resin. Thus, the melt index of the polymer as made in the reactor (the fluff) will be higher than the melt index of the extruded pellets. (Tr. 370.)[26]

For instance, for HHM TR-400, a Phillips pipe resin, the melt index specification for one pelletized product is given as the range of 0.15 to 0.25, whereas the melt index specification for the same resin in fluff form is the higher range of 0.35 to 0.45. (PX 1238 and PX 634 at L124623.) In the case of HHM TR-400, the melt index specification of the pelletized Phillips product is below 0.3 which is the lower melt index limit of claim 5 of the '698 patent. However, the HHM TR-400 product is still within the scope of claim 5 because the melt index specification for that product in fluff form is above 0.3. (Tr. 468, 416.) Thus, in general, if the melt index of a Phillips copolymer

[26] *See* PX 1238 and 1238A—the summary charts on properties of Phillips fluff products—and the exhibits referred to in those charts—PX 219, 220, 223, 232, 324, 327, 334, 344, 375, 414, 634.

product, as fluff, is within the melt index range of an asserted claim, then that Phillips product infringes that claim on the basis of melt index, even though the melt index of the extruded, pelletized product as sold is outside of the melt index range of the asserted claim. This is so because, by statute, one who "*makes, uses* or sells" a patented invention is an infringer. 35 U.S.C. § 271(a).

The Court finds that accused Phillips ethylene-hexene-1 copolymers individually listed in Appendix I fall within the scope of the asserted claims of DuPont's '698 patent as to melt index.

3. *Claim Parameters*

The ethylene-higher alpha-olefin copolymers of the '698 patent are characterized by several parameters so that they can be distinguished by external tests from linear ethylene homopolymers and from linear ethylene copolymers that are rubber-like. The parameters are measurements of comonomer content (determined by infrared spectroscopy), density and percent crystallinity. (*See* Section II, A.1 above.)

a. Comonomer Content Determined By Infrared Spectroscopy

As stated above, comonomer content is a measurement of the presence and amount of comonomer in the ethylene-higher alpha-olefin copolymer. The only point on this issue disputed at trial was the "1% . . . by weight" recitation of claim 2.

At trial, DuPont presented infrared spectroscopy comonomer content data for the accused Phillips products that were determined from measurements of the total methyl group concentration in the copolymers. (Tr. 1052.) This was the technique generally used in the 1950's

and DuPont followed it in making the infrared based measurements disclosed in the '698 patent.

The method that DuPont followed was to measure the total number of methyl groups per 100 carbon atoms in the copolymer and to then calculate the percent comonomer directly from that data without correcting for the presence of methyl groups at the end of the copolymer chains which do not represent comonomer branches. (Tr. 1052-54; 380-83.) To calculate the percent comonomer by weight, this value is multiplied by the number of carbon atoms in the comonomer chain. (Tr. 384-89.) For example, as shown in PX 1235B, DuPont's summary chart of the properties of the accused Phillips products, the number of methyl groups per 100 carbons for HHM 4515 is 0.61. This represents a comonomer content of 3.66% by weight for the six carbon hexene comonomer in HHM 4515 ($0.61 \times 6 = 3.66$).

The evidence established that determining comonomer content from uncorrected infrared methyl group concentration measurements was the approach that was generally used in the mid-1950's and that is what DuPont did in that period and that is how the comonomer content data in the '698 patent were obtained. (Tr. 1048, 3611-13, 380-84; PX 583; DX 571.) Indeed, in the 1950's and 1960's, the infrared lab at Phillips, like the lab at DuPont, reported methyl groups per 100 or 1000 carbon atoms uncorrected for end groups by its researchers, including Messrs. Hogan and Leatherman. (Tr. 2608-18; PX 1334, 1336, 1337, 1338; PX 84.) Hercules also used the uncorrected methyl group approach in measuring comonomer content by infrared spectroscopy in the 1950's. (Tr. 3474.)

In fact, Phillips used the uncorrected approach as recently as this year in determining comonomer content

data for the samples Witt and Leatherman made in the 1950's. Phillips' infrared expert, Dr. David M. Wiles, calculated the comonomer contents for these samples exactly the same way that DuPont did for this litigation. He multiplied the uncorrected methyl groups per 100 carbon atom measurements by the number of carbons in the comonomer to determine percent comonomer and reported the results in an affidavit which Phillips submitted to the United States Patent and Trademark Office. (PX 1340; Tr. 2812-14.)

The accuracy of the infrared method used at DuPont in the mid-1950's (PX 583) was plus or minus 0.1 methyl groups per 100 carbons. (Tr. 3615.) Phillips' documents from the 1950's show an even larger margin of error of plus or minus 0.2 methyl groups per 100 carbons. (PX 1342 at 4; Tr. 3615.) As Dr. Edward G. Brame, Jr., explained, for an ethylene-hexene-1 copolymer, an accuracy of plus or minus 0.1 methyl groups per 100 carbons would translate into a margin of error of plus or minus 0.6% by weight of hexene-1 in the copolymer. (Tr. 3615-16.) For 1% comonomer content, the accuracy would be from about 0.4% to 1.6% by weight. (*Id.*) Using the Phillips value for accuracy of plus or minus 0.2 methyls, the range would be even greater. (Tr. 3616.)

This is consistent with Dr. Beasley's testimony that the Phillips ethylene-hexene-1 copolymers which are accused of infringement and which have only a small amount of hexene-1 comonomer present are within the scope of the asserted claims. Dr. Beasley, in characterizing the purpose of the "1% . . . by weight" recitation in claim 2, testified (Tr. 139):

> The smallest whole number that could be cited would be one percent, so I interpret this to mean that

> the inventors are teaching that a small amount of comonomer can be effective in improving properties, and that at the time they wrote up the patent, they didn't have the measurements to state exactly what the cutoff point might be if, indeed, there is one.
>
> So they are saying one percent, meaning a small amount of comonomer. . .
>
> * * *
>
> Very clearly, again, to repeat this morning, the invention is the improvement in properties, and I read these numbers to say the properties are improved over a very wide range of comonomer content, down to very low levels.

Accordingly, the Court finds that the 1% by weight comonomer level stated in claim 2, when interpreted in light of the art as it existed in the mid-1950's when the work reported in the '698 patent was performed, would include copolymers with small amounts of comonomer. This would include those with about 0.45 by weight hexene comonomer.

At trial, Phillips used two different techniques for measuring comonomer content in order to reduce the comonomer contents results below 1% by weight for as many of its products as possible in order to avoid infringement of claim 2. First, Phillips presented infrared determinations which included a correction factor that was not widely used in the mid-1950's for ethylene copolymer analysis. (Tr. 2787-93; DX 906A; DX 2704.) Second, Phillips presented data based on a carbon 13 nuclear magnetic resonance spectroscopy ("NMR") technique which was not developed until the 1970's. (Tr. 2935-36.)

These two methods used by Phillips to avoid infringement of claim 2 for a number of its products are unavailing. Infringement is determined based on the

claims of the patent as construed by the methods generally used by those skilled in the art at the time the patent application was filed, not by other methods not then generally used or which were developed later in order to obtain lower results. Swift Chemical Co. v. Usamex Fertilizer, Inc., 490 F.Supp. 1343, 1354 (E.D.La. 1980), *affirmed per curiam,* 646 F.2d 1121 (5th Cir. 1981); Raybestos-Manhattan, Inc. v. Texon, Inc., 268 F.2d 839, 841-42 (1st Cir. 1959). When comonomer content is determined by the method generally used by DuPont and others to determine comonomer content in the 1950's, all of the Phillips products accused of infringement and shown in Appendix I attached hereto have comonomer contents of 1% of weight or greater. The few products of Phillips with values of less than 1% by weight, such as HHM 5502 with 0.84% and DTR with 0.96%, are for all intents and purposes 1%. (Tr. 406, 408, 498.)

DuPont's comonomer content proofs are based on two showings of infringement. First, that the comonomer content data determined by the uncorrected infrared spectroscopy technique used in the mid-1950's by DuPont, as well as by Phillips and Hercules, establish that the accused Phillips copolymers meet the 1% by weight limitation of claim 2. Second, that when the margin of error inherent to such determinations in the mid-1950's is taken into account, even the comonomer content data Phillips has presented at trial, whether by NMR or by correcting DuPont's infrared data, also prove literal infringement of claim 2.

Phillips has overlooked the second showing completely. Thus, even if Phillips' challenge to DuPont's comonomer content proofs are accepted, the data presented at trial by Phillips is sufficient to sustain DuPont's burden of proof as to the infringement of claim 2.

A pertinent case is Cosden Oil & Chemical Co. v. American Hoechst Corp., 543 F.Supp. 522 (D.Del. 1982), which Phillips relies on to urge the relevance of its NMR data. There, in discussing evidence concerning infrared and NMR analyses relied upon to prove infringement, the Court stated (*id.* at 530):

> I agree that the state of the art of measurement in a particular field may be highly relevant in construing a patent and determining the scope of its claims. The statute charges the applicant with communicating his invention to those skilled in the art and his teachings are to be understood in light of the art as it then existed. In determining the boundaries of "not more than about 10%," for example, it is helpful to know the margin of error in the measurement techniques of the day.

Thus, for those Phillips products which Phillips contends have less than 1% comonomer, claim 2 plainly includes them when it is construed in light of the degree of accuracy of infrared spectroscopy in the 1950's, as required by *Cosden Oil.*

The accused Phillips products with greater than 1% by weight of hexene-1 comonomer are within the literal scope of claim 2.[27] As for those products which Phillips

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[27] These 23 products are: HHM 4515, HMN 4550 (BX-470), HHM 4903, HMN 5060 (BX-573), HHM TR-130 (D-320), HHM TR-140 (D-420), HHM TR-144 (D-422), HHM TR-210 (J-440), HHM TR-230 Black (J-320 or J-339), HHM TR-232 Black (J-322), HHM TR-232 Yellow (J-325), HHM TR-250 Black (J-510), HHM TR-400 (H-310), HHM TR-401 (H-460), HHM TR-416 Black, HHM TR-418 Black, HHM TR-418 Orange, 728 Fluff, 728-01, HHM TR-480 Black, HMN TR-938 JV, HMN TR-942 JV and D-321.

The same would be true for similar or equivalent Phillips products for which no samples were available, such as the following 23 products: HHM 4520, HHM 4903-01, HHM TR-100, HHM TR-102, HHM TR-150 (D-506), HHM TR-226 (J-426), HHM TR-236 Black, HHM TR-257 (J-517), HHM TR-415 Black, HHM TR-418 White, HHM TR-418 Yellow, HHM TR-418-01 Orange, HHM TR-460, HMN TR-938 (LX-471), HMN TR-942 (LX-470), HMN TR-950 (LX-571), D-510, H-328, J-425, D-310 (or M-320), D-442, M-339F (Fluff) and M-428.

contends have less than 1%, claim 2, when construed in light of the degree of accuracy of infrared spectroscopy in the mid-1950's, also plainly includes them.[28]

The Court concludes that DuPont has met its burden of proving by a preponderance of the evidence that the accused Phillips ethylene-hexene-1 copolymers fall within the literal scope of the asserted claims of the '698 patent as to comonomer amount. The comonomer amount data determined by the uncorrected infrared spectroscopy technique used in the mid-1950's that DuPont presented at trial (Appendix I) established that the accused Phillips copolymers met the 1% by weight limitation of claim 2. In addition, DuPont has established that when the margin of error inherent to such determinations in the mid-1950's is taken into account, the comonomer amount data which Phillips presented at trial also prove literal infringement.

b. Density and Crystallinity

As noted before, density and percent crystallinity are also indicators of the amount of comonomer, aiding to distinguish the copolymers of the invention from linear ethylene homopolymers and from linear ethylene copolymers that are rubber-like. As comonomer is incorporated in a linear polyethylene chain, both the density and degree

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[28] These 14 products are: HHM 5202, HHM 5202-02-LD, HHM 5502, HHM 5502-01, HHM 5502-02-LD, HMN 54140 (BX-574), HMN 5580 (BX-572), HHN 5710 (GX-571), HMN 6060 (BX-672), DTR, DTR-01, BX-575, BX-671JX (BX-671) and DX 611 (DX 2657; DX 2704).

The following 13 similar or equivalent Phillips products for which no samples were provided would be within the scope of claim 2 for the same reason: HHM 5202-01, HHM 5502-LD (Dr. Hsieh's NMR evaluation in 1985 gave a value of 0.48% by weight—DX 2178), HHM 5502-03, HMN 5550, HMN TR-954 (LX-570), BX-579, BX-673, C-551, C-552-LD, C-555, D-521, ER9-0032 and JX-676.

of crystallinity decrease from the values measured with linear polyethylene homopolymer. (Tr. 132.) This is so because the branches formed by the higher alpha-olefin comonomer tend to disrupt the crystalline structure and lower the crystallinity and density of the copolymers. (Tr. 43; 1177.)

The only density issue disputed at trial was the "0.95" density recitation of claims 2 and 5.

As Dr. Beasley explained, the "0.95 at 1%" recitation in claim 2 describes "these materials as having a relatively high density at a relatively low comonomer content" and is not limited to materials with density of 0.9500 or less. (Tr. 139-40.) Dr. Beasley went on to point out *(id.)*:

> So they are saying one percent, meaning a small amount of comonomer, and that in the process the catalyst and so forth they were working with, that small amount of comonomer would correspond to a density of .95, again reported only to two significant figures, which, again, means that it is about .95, not .9500.

The figure 0.95 is not limited to 0.9500 for a density measurement. Density can be accurately measured to four significant figures, e.g., 0.9538. (Tr. 359.) Also, by customary scientific notation 0.95 does not mean 0.9500. Because 0.95 is stated to only two significant figures (as opposed to 0.950 or 0.9500) it includes on its face values between 0.9451 and 0.9550. *See, e.g.*, Air Products and Chemicals, Inc. v. Chas. S. Tanner Co., 219 USPQ 223, 246 (D.S.C. 1983).

The 0.95 density recitation of claims 2 and 5 also must be read in the context of the disclosure in the '698 patent to the effect that comonomer amount has on

density. The density data that are included in the '698 patent show that as small amounts of comonomer are added to achieve superior properties, density decreases. (Tr. 132.) Specifically, for the linear polyethylene homopolymers described in the '698 patent, the densities range from 0.945 to 0.960. As the '698 patent shows, when comonomer was added the density decreased to lower levels. (Tr. 132, 360-61.) Thus, the 0.95 density figure recited in claims 2 and 5 is representative of the density that was obtained by adding a small amount of comonomer to what otherwise would be an ethylene homopolymer. As Dr. Beasley testified, the purpose of this limitation is to "distinguish copolymers from homopolymers." (Tr. 888-89.)

However, depending on the process used, the density of a copolymer with a small amount of comonomer can be greater than the value of 0.95 recited in claims 2 and 5. (Tr. 135, 140; Appendix 1.) For example, Phillips' commercial polyethylenes generally have densities in the order of 0.96. (Tr. 931; DX 2365C.) As small amounts of comonomer are added to the Phillips products, the densities will drop below that of the homopolymer. (Tr. 132.)

As this Court held in Clopay Corp. v. Blessings Corp., 422 F.Supp. 1312, 1325-26 (D.Del. 1976):

> Ultimately, the answer must depend on whether a person skilled in the art would read the claim of the patent to contemplate a range which includes the accused product.

Based on the evidence discussed above, the Court finds the 0.95 density recitation of claims 2 and 5 would be read by one skilled in the art to include products with

densities greater than 0.9500 where small amounts of comonomer have been added to form a copolymer reducing the density from the level for polyethylene homopolymer made by the same process.

Dr. Beasley, a person skilled in this art, read the 0.95 density recitation of claims 2 and 5 as including all of the accused Phillips hexene-1 copolymer products, either literally or under the doctrine of equivalents. (Tr. 322-24; 390-565.)

With the accused hexene-1 copolymers for which samples were available, DuPont determined densities using two sample preparation techniques, the DuPont 1955 sample preparation method and the method described in ASTM D 1928 Procedure C. (PX 1235; PX 677 (ASTM D 1928); Tr. 1018-19.)[29] In both cases, the density of the specimens was determined using the density gradient tube method described in ASTM D 1505. (PX 673; Tr. 1018.) Phillips, in its product brochures, reports densities as determined by ASTM D 1505 on samples prepared in accordance with ASTM D 1928, Procedure C. (*See, e.g.*, PX 158, 189, 196, and PX 317-322.)

The evidence demonstrated that the two methods of sample preparation used by DuPont give density values which compared well with each other. (Tr. 1021, 3634; PX 1367.) A plot of the density data determined by both methods (PX 1367) showed that "the correlation between

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[29] The DuPont 1955 sample preparation method is described at P000897 of PX 1246:

> The density values given in this report are for conditioned samples prepared by molding at temperatures well above the melting point (150-160°C), cooling rapidly to 65°C in 2 to 4 minutes, and then conditioning by boiling in water for 1 hour and storing at 23°C for at least 30 minutes.

Procedure C of ASTM D 1928 differs in that it specifies a cooling rate of 15°C per minute and does not require conditioning in boiling water for one hour.

the two different methods of measuring density is, indeed, very good." (Tr. 3634.) The differences in density between samples prepared by the two methods was very small. (Tr. 1021.)

In presenting density values at trial, Phillips used Procedure C of ASTM D 1928 for sample preparation. However, the densities of the specimens so prepared were determined by the displacement in water method rather than by the density gradient tube method that Phillips uses for the density values reported in its product brochures. (Tr. 2860-63, 2873-75; DX 5521 which is ASTM D 792.) Nevertheless, the results of the method used by Phillips also correlated well with the results of the DuPont 1955 method. (PX 1369; Tr. 3638.)

From the measured density values on the 37 products for which samples were available, DuPont has established that by the 1955 DuPont method, 20 Phillips products have densities of 0.9500 or less[30] and five additional products[31] are resins containing carbon black whose feedstock copolymer resins have density specifications of 0.9500 or less. Those products literally infringe. Of the remaining twelve samples, nine have measured densities below 0.9550 and literally infringe,[32] while the other three have densities of 0.9589, 0.9593 and 0.9597 and infringe under the doctrine of equivalents.[33] As to the remaining

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[30] HHM 4515, HMN 4550 (BX-470), HHM 4903, HMN 5060, HHN 5710 (GX-571), HHM TR-130 (D-320), HHM TR-140 (D-420), HHM TR-144 (D-422), HHM TR-210 (J-440), HHM TR-232 Yellow (J-325), HHM TR-400 (H-310), HHM TR-401 (H-460), HHM TR-418 Black, HHM TR-418 Orange, 728 Fluff, 728-01, HMN TR-938 JV, HMN TR-942 JV, DTR-01 and D-321.

[31] HHM TR-230 Black (J-320 or J-339), HHM TR-232 Black (J-322), HHM TR-250 Black (J-510), HHM TR-416 Black and HHM TR-480 Black.

[32] HHM 5202, HHM 5202-02-LD, HHM 5502, HHM 5502-01, HHM 5502-02-LD, HMN 54140 (BX-574), HMN 5580, DTR and BX-575.

[33] HMN 6060 (BX-672), BX-671JX (BX-671), and DX-611.

36 products accused of infringement, for which no samples were provided to DuPont, twenty-two have densities of 0.9500 or less according to Phillips' own advertised or specification data,[34] one (HHM 5202-01) has a density specification which overlaps 0.9500, and eight have densities at or below 0.9550 or which overlap 0.9550.[35] Those products literally infringe. The other five have densities above 0.9550.[36] Of the five with densities above 0.9550, one product, HHM TR-415 Black, contains carbon black and its feedstock resin, 721 P or F, has a density specification of 0.941-0.944 so as to literally infringe. (PX 323, 324; D.I. 243 at 465-67.) The other four products (BX-673; JX-676; ER-9-0032 and D-521) had densities of 0.960, 0.961, 0.9589 (measured on the feedstock), and 0.958 and infringe under the doctrine of equivalents.

Turning to percent crystallinity, the only issue disputed at trial was the "70%" crystallinity recitation of claim 5 and its dependent claims 10, 12 and 14.

As with density, the crystallinity of an ethylene copolymer decreases from the value measured for polyethylene homopolymer as comonomer is added. (Tr. 132.) The '698 patent specification and claim 5 specify that crystallinity is to be determined by X-ray methods. (PX 1, col. 3, l. 63; col. 4, ll. 15 and 67; Tables I and II; col. 8, ll. 34-63; col. 14, l. 8 (claim 5)).

By using X-ray methods to determine crystallinity in copolymers, "it's relatively easy to say one sample has

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[34] HHM 4520, HHM 4903-01, HHM TR-100, HHM TR-102, HHM TR-150, HHM TR-226, HHM TR-236 Black, HHM TR-257, HHM TR-418 White, HHM TR-418 Yellow, HHM TR-418-01 Orange, HHM TR-460, HMN TR-938 (LX-471), HMN TR-942 (LX-470), HMN TR-950 (LX-571), D-510, H-328, J-425, D-310 (or M-320), D-442, M-339F (Fluff), and M-428.

[35] HHM 5502-LD, HHM 5502-03, HMN 5550, HMN TR-954 (LX-570), BX-579, C-551, C-552-LD and C-555.

[36] BX-673, JX-676, ER9-0032, D-521, and HHM TR-415 Black.

more crystallinity than another sample." (Tr. 130.) However, the lab to lab variation for X-ray crystallinity values on a given sample can vary significantly.

Dr. Frank C. Wilson, who has worked in X-ray diffraction for almost 30 years, testified that because of the subjective judgments involved in the procedure, the overall degree of variance in X-ray crystallinity measurements would be on the order of 10% to 20% between one lab and another without considering variance due to scatter. (Tr. 1041.)[37] This is consistent with Dr. Beasley's testimony that of the various parameters in the claims of the '698 patent, "the percent crystallinity is the weakest of these measurements in terms of the reproducibility of the test." (Tr. 412.)

The Phillips hexene-1 copolymers accused of infringement have measured or interpolated X-ray crystallinities in the range of about 65% to 85%. (PX 1235B and Appendix I.) Any Phillips hexene-1 copolymer product with a crystallinity of 70% or below would fall within the range of 40 to 70% of claim 5.[38] The other Phillips hexene-1 copolymer products accused of infringement would fall within the range of variance given by Dr.

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[37] The complex procedure followed in making X-ray crystallinity measurements and the subjective judgments involved were explained by Dr. Wilson in detail at trial. (Tr. 1033-43.)

[38] This would include 28 Phillips produces—HHM 4515, HHM 4520, HHM TR-130 (or D-320), HHM TR-210 (or J-440), HHM TR-226 (or J-426), HHM TR-230 Black (or J-320 or J-339), HHM TR-232 Black (or J-322), HHM TR-232 Yellow (or J-325), HHM TR-236 Black, HHM TR-400 (or H-310), HHM TR-418 Black, HHM TR-418 Orange, 728 Fluff, 728-01, HHM TR-418 White, HHM TR-418 Yellow, HHM TR-418-01 Orange, HHM TR-460, HHM TR-480 Black, HMN TR-938 (or LX-471), HMN TR-938 JV, HMN TR-942 JV, HMN TR-942 (or LX-470), H-328, J-425, D-310 (or M-320), D-321, and M-339F (Fluff).

Wilson of plus or minus 10% to 20%.[39] Furthermore, the Phillips hexene-1 copolymers with X-ray crystallinities greater than 70% would infringe under the doctrine of equivalents.

The Court concludes that DuPont has met its burden of proving that the accused Phillips ethylene-hexene-1 copolymers are within the scope of the asserted claims of the '698 patent as to X-ray crystallinity and density.

It must be noted that Phillips advanced five prosecution history estoppel arguments related to the claim parameters of density, crystallinity, and comononer content in an effort to restrict the scope of the asserted claims. (D.I. 259 at 106-127.) The Court has considered all these estoppel arguments. Without dealing specifically with each and thereby extend this too-detailed opinion even further, the Court makes the following general comment with regard to Phillips' arguments.

Prosecution history estoppel is applied to limit the application of the doctrine of equivalents after the claims have been properly interpreted and no literal infringement is found. Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 870 (Fed.Cir. 1985). Estoppel does not involve a reinterpretation of the claims. *Id.* at 870-71. If there is literal infringement, prosecution history estoppel is not applicable. Fromson v. Advance Offset Plate, Inc., 720 F.2d 1565, 1571 (Fed.Cir. 1983). Prosecution history estoppel is to be invoked as a legal matter on a case-by-case basis, guided by the equitable and public policy principles underlying the two doctrines involved and by the facts of the particular case. Moeller v. Ionetics, Inc.,

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[39] This would apply to those Phillips products with X-ray crystallinities only slightly greater than 70%, such as: HMN 4550 (or BX-470) = 70.5%, HHM TR-140 (or D-420) = 72.5%, HHM TR-144 (or D-422) = 71.9%, HHM TR-401 (or H-460) = 71.4%, HHM TR-415 Black and HHM TR-416 Black = 72%.

794 F.2d 853, 659 (Fed.Cir. 1986); Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 871 n.7 (Fed.Cir. 1985).

The Court finds none of Phillips' arguments involve the classic situation for estoppel, such as if DuPont had narrowed a claim by amendment and now sought to recapture what was given up by resort to the doctrine of equivalents. Instead, Phillips points to various statements made by DuPont's attorneys during the prosecution leading up to the issuance of the '698 patent.[40] Phillips states that estoppel applies "to arguments ... submitted to obtain the patent." (D.I. 259 at 109.) That statement, which appears in opinions such as Hughes Aircraft Co. v. United States, 717 F.2d 1351, 1362 (Fed.Cir. 1983), has never been interpreted by the Federal Circuit as meaning every argument which appears anywhere in the prosecution history.

In Environmental Designs, Ltd. v. Union Oil Co. of Cal., 713 F.2d 693, 699 (Fed.Cir. 1983), the Federal Circuit rejected an argument that the patent owner was "estopped from asserting the plain language of the claim by its remarks to the examiner," where the remarks were made to overcome a rejection under 35 U.S.C. § 112, and not to overcome a rejection based on prior art. To the same effect is Caterpillar Tractor Co. v. Berco, S.P.A., 714 F.2d 1110, 1115 (Fed.Cir. 1983), where the Court held that arguments made to overcome a Section 112 rejection did not raise an estoppel. In addition, in Schenck v. Nortron Corp., 713 F.2d 782, 786 (Fed.Cir. 1983), no estoppel was applied where the claim language relied on for the estoppel argument was not inserted in the claim to avoid prior art and the principle arguments made in the prosecution history to distinguish the prior art focused on features which were clearly present in the accused device.

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[40] Phillips cites one instance (D.I. 259 at 126), during the reissue/reexamination proceedings.

Thus the Court finds that Phillips' estoppel contentions are nothing but red-herring arguments without merit.

c. Doctrine of Equivalents

To the extent that the parameters of comonomer amount, density and crystallinity recited in the asserted claims are not literally infringed, then those claims are infringed under the doctrine of equivalents.

The Phillips accused products and the claimed invention of the '698 patent perform the same function (modification of a linear ethylene homopolymer), in the same way (use of a higher alpha-olefin comonomer) to achieve the same result (superior impact strength and stress crack resistance). Thus, under the doctrine of equivalents discussed in Section VI, A above, Phillips has appropriated the essence or heart of the '698 invention and its products infringe that patent.

4. Improved Impact Strength And Stress Crack Resistance

The evidence also clearly demonstrated that the infringing ethylene-hexene copolymers use the invention disclosed and claimed in the '698 patent in that Phillips uses hexene as a comonomer in order to obtain improved impact strength and stress crack resistance.

This evidence comes directly from Phillips' own documents, summarized in PX 1237 and 1237A. For many Phillips products environmental stress crack resistance is said to be "excellent," "exceptional," "high," "outstanding," "good," and as meeting various industry specifications for stress crack resistance. For those and other Phillips products, impact resistance is said to be "excellent" and "good." Phillips' brochures also report

specific numerical values for stress crack resistance and impact strength properties such as Elmendorf tear strength.

Phillips' use of the claimed invention is confirmed by other statements in Phillips' advertising literature (such as PX 1228 and PX 72 at 2), by Phillips' conduct in proclaiming the improved stress crack resistance which could be obtained with hexene to its licensees in the 1960's,[41] and by Phillips' conclusion in 1980 that it could not convert its hexene copolymers back to noninfringing butene copolymers because,

> "Butene does not impart the stress cracking resistance to ethylene copolymers that hexene does."

(PX 133.)

In a 1969 product brochure for Marlex HHM 5502 (PX 1228), Phillips states as "Special Characteristics":

> This resin has outstanding container environmental stress cracking resistance and impact strength that is superior to other HDPE resins of equivalent density and melt index.

Thus, shortly after Phillips introduced hexene copolymer products to the marketplace, Phillips was using the advantages provided by the invention of the '698 patent to distinguish its hexene copolymer products from "other HDPE resins" such as butene copolymers. A 1975 Phillips brochure also recognized Phillips' use of the claimed invention (PX 72 at 2; Tr. 3232-33):

> However, it has been shown that the type of branching as well as the concentration can exert a pronounced effect on performance. For exam-

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[41] *See* PX 48 (sent to all Phillips licensees), PX 51 (sent to all Phillips licensees), PX 59 (sent to Gulf), PX 60 (sent to Union Carbide), PX 61 (sent to Japan Olefin Chemicals), PX 62 (sent to Gulf), PX 63 (sent to Allied), and PX 64 (sent to BP Chemicals).

> ple, when hexene is introduced as a comonomer in place of butene, a marked increase in ESCR occurs at the same density or crystallinity level.

Phillips now contends that its own advertising brochures do not disclose improved properties, and argues that DuPont should have presented "data concerning the tear strength and stress crack resistance of Phillips products."[42] (D.I. 259 at 130 and n.28.) DuPont did present such data, which came from Phillips' own records and Dr. Beasley summarized Phillips' data when he testified (Tr. 609-11):

> The heart of the invention is to use higher alpha-olefins to get better properties than it is possible to get with propylene and butene. It's that simple.
>
> Now, harking back to what I said, you look at the total combination of properties, not just any one alone. When you look at the total, the higher alpha-olefins enables someone skilled in the art who understands polymerization, knows what he's doing to make a better product.
>
> * * *
>
> It is very clear that these [Phillips] products make use of higher alpha-olefins to get better properties than would be possible with butene.
>
> Knowing that Phillips has intelligent engineers and chemists, they know a lot about polymerization, they know how to do the job. There is evidence from various Phillips' reports that they fully recognize that hexene gives better properties than butene.
>
> They made use of this knowledge.
>
> * * *

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[42] Phillips did not explain how DuPont was supposed to obtain measured data on the 36 accused Phillips product for which no samples were provided. Nor does Phillips explain how DuPont could have obtained non-infringing butene copolymers made by the same process for purposes of comparison to show that the hexene copolymers had improved impact toughness and stress crack resistance.

> I believe the question was has Phillips used the invention to make products? We have gone through a long list of products in which I have testified that, indeed, this invention is being used to improve properties.
>
> In my opinion, they do fall within the scope of the claims. To answer your question directly, my opinion is that Phillips has used this invention.

The Court finds that DuPont has carried its burden of proving that the accused copolymers use hexene to achieve superior impact strength and stress crack resistance.

5. Elmendorf Tear Strength And Infringement Of Claim 1

Claim 1 of the '698 patent recites that the copolymers have "when in the form of a film, an Elmendorf tear strength in the range of 150 to 400 grams per mil." (PX 1, col. 13, ll, 23-25.) DuPont measured the Elmendorf tear strengths of Phillips hexene-1 copolymers listed on PX 1239 and established that they have, when in the form of a film, Elmendorf tear strengths of 150 grams per mil or greater within the accuracy of that test:

Phillips Copolymer	ETS g/mil
HHM TR-230	153
HHM TR-232 Black	147
HHM TR-232 Yellow	149.5
HHM TR-130	152
HHM TR-418 Black	178
HHM TR-418 Orange	146
728 Fluff	165
728-01	181

The Elmendorf tear strength values were determined using a modified version of the Elmendorf tear strength test for paper (ASTM D 689-44 or PX 601) on compression molded films about 10 mils thick. (Tr. 1022-23.) This was consistent with the procedure used in the 1950's. (Tr. 1023, 742-43.)

Based on this and the other data Dr. Beasley testified that those eight copolymers were within the scope of claim 1. (Tr. 426-27 [HHM TR-130], Tr. 436-37 [HHM TR-230], Tr. 441-42 [HHM TR-232 Black], Tr. 443-44 [HHM TR-232 Yellow], Tr. 473-74 [HHM TR-418 Black], Tr. 475-76 [HHM TR-418 Orange], and Tr. 477 [728 Fluff and 728-01].)

Phillips contends that 3 of these 8 products have tear strength values below 150 grams per mil "minimum." (D.I. 259 at 128.) Those three products, HHM TR-232 Black, HHM TR-232 Yellow, and HHM TR-418 Orange, had values of 147, 149.5 and 146, respectively. Dr. Beasley, however, testified that because the Elmendorf tear strength test is subject to some error, these values would be equivalent to 150. (*Id.*) Phillips offered no evidence to rebut that testimony.

Phillips' second argument, that DuPont used a "biased" sample preparation technique, also fails. Dr. Richard W. Rees testified that he used a conventional compression molding technique. (Tr. 1022, 1025-26.) The technique urged by Phillips, PX-677 or ASTM D 1928 Procedure C (¶ 6.9), is the present day compression molding procedure for preparing samples for determining density. It was not a standard procedure in the 1950's and is a somewhat unusual molding technique. (Tr. 1025.) The evidence establishes that the DuPont researchers in the 1950's used cooling water on "full" to compression

mold samples (PX 1246 at P000895), or the same technique as used by Dr. Rees.

The Court finds based on the credible evidence that DuPont has carried its burden of proving that the eight copolymers met the Elmendorf tear strength level specified in Claim 1.

6. Hoop Stress And Infringement Of Claim 12

Hoop stress resistance measures the performance of plastic pipe when subjected to long-term stress. (Tr. 117-18.) Claim 12, which is dependent on claim 5, recites that the claimed copolymers "in the form of pipe" are "further characterized by withstanding 3,000 hours of hoop stress of 750 psi and a temperature of 60°C. (PX 1, col. 14, 11. 28-30.)

Again Phillips' own data demonstrated that this performance test could not be met by pipe made from a 0.2 melt index ethylene homopolymer or from a 0.2 melt index ethylene-butene copolymer. (PX 1242 and the charts—PX 1224 and 1225—made from Figures 4 and 5 of PX 1242.) The 0.2 melt index ethylene homopolymer pipe would fail in a little less than 200 hours (about one week) and the 0.2 melt index ethylene-butene copolymer pipe would fail at about 400 hours (a little over two weeks). (Tr. 575-76; PX 1224 and 1225.) However, a 0.2 melt index ethylene-hexene copolymer not only would meet the 3,000 hours (about 18 weeks) called for by claim 12, but would not fail at over 100,000 hours (over 10 years), based on an extrapolation of the Phillips data (*see* chart PX 1223, made from Figure 6 of PX 1242 and Tr. 577).

Dr. Beasley's testimony established that nine pipe products made by defendant Phillips Driscopipe, Inc.

("Phillips Driscopipe"), and pipe made from the resins sold by Phillips 66 Company for use in pipe, meet the performance criteria set forth in claim 12 and infringe that claim.

Dr. Beasley testified that, based on Phillips' documents[43] and based on the evidence summarized in PX 1236 and PX 1245, the following Phillips Driscopipe pipe products would fall within the scope of claim 12 of the '698 patent:

Driscopipe 1000	Driscopipe 3400
Driscopipe 6300	Driscopipe 3700
Driscopipe 6400	Driscopipe 3800
Driscopipe 6500	Driscopipe 3900
Driscopipe 3300	

First, Dr. Beasley explained that Driscopipe 6500 was within the scope of claim 12, based on Figure 1 of PX 466, a brochure for Driscopipe 6500. (Tr. 578-79.) Figure 1 (at L124833) is a plot of hoop stress in psi versus time in hours, with one line at 150°F (65°C, slightly higher than 60°C), and another at room temperature. Figure 1 shows that at 65°C and a hoop stress of 750 psi, Driscopipe 6500 would not have failed within 3,000 hours. The same would undoubtedly be true at the less rigorous lower temperature of 60°C.

Dr. Beasley then explained that Driscopipe 1000 was within the scope of claim 12, because PX 443, a brochure for Driscopipe 1000, specifies a long term strength of 800 psi at 140°F (60°C), as determined by ASTM D 2837.

[43] Such as PX 443 (Driscopipe 1000), PX 460 (Driscopipe 3300 and 3400), PX 466 (Driscopipe 6500) and PX 470 (Driscopipe 6400). These documents report hoop stress or long term strength properties of pipe. ASTM D 2837 (PX 1244) is the procedure for obtaining long term strength (in psi) for plastic pipe referred to in these Phillips documents.

(Tr. 579-82.) ASTM D 2837 defines the long term strength of plastic pipe as the estimated tensile stress in the pipe wall in the circumferential direction that, when applied continuously, will cause failure of the pipe at 100,000 hours. (PX 1244, ¶ 4.5.) This tensile stress is the same as hoop stress. (Tr. 581-82.) If Driscopipe 1000 would withstand a hoop stress of 800 psi at 140°F (60°C) for 100,000 hours, it would certainly withstand a lower hoop stress of 750 psi at 60°C (140°F) for 3,000 hours as called for by claim 12. (Tr. 582.)

The Phillips Driscopipe brochures for Driscopipe 6400 (PX 470), and Driscopipe 3300/3400 (PX 460) like the brochure for Driscopipe 1000, report a long term strength (failure at 100,000 hours) of 800 psi at 140°F by ASTM D 2837. Consequently, the Driscopipe 6400, 3300, and 3400 products also are within the scope of claim 12 of the '698 patent. (Tr. 583-85).

According to the deposition testimony of Mr. Benny E. Nasser, a Rule 30(b)(6) witness for Phillips Driscopipe, the Driscopipe products 3700, 3800, and 3900 are made from resins HHM 5202 or HHM 5502. (D.I. 239 at 67.) Mr. Nasser also testified that Driscopipe 3300 and 3400 were made from resins HHM 5202 or HHM 5502 as well as from other Phillips resins. (D.I. 230 at 19, 65-67.) Based on this evidence from Phillips (summarized in PX 1236 and 1245), Dr. Beasley concluded, and the Court agrees, that because all of the resins used to make Driscopipe 3300/3400 would meet the long term strength specification in the brochure for 3300/3400 (PX 460), then Driscopipe 3700, 3800, and 3900 also would meet the same long term strength specification, namely at 140°F they would withstand a hoop stress of 800 psi for 100,000 hours and would be within the scope of claim 12.

(Tr. 586-86a.) Similarly Driscopipe 6300, which is made from Phillips' resins which also are used to make 3300/3400, would be within the scope of claim 12. (Tr. 587.)

The evidence further established that Phillips sells the resins HHM TR-401, HHM TR-418 Black, HHM TR-418 Orange, and HHM TR-480 Black for use in making pipe, and that pipe fabricated from those resins would be within the scope of claim 12. (Tr. 587-89.) Thus, Phillips has actively induced infringement of claim 12 by selling these resins for *use* in pipe.

The only argument Phillips specifically advanced (other than its estoppel arguments that claim 12 has a 0.935 upper limit for density, and its argument based on claim 5 on which claim 12 depends and found to be wanting by the Court) is that DuPont did not present any hoop stress data. This, however, is not an issue before this Court. There is no evidence of record concerning what pipe samples were provided to DuPont, and more importantly, when they were provided. DuPont contends that after numerous requests, it did not receive any pipe samples from Phillips until the end of May 1986, when it was too late for DuPont to run any hoop stress tests in time for submission of the results at trial. The Court need not resolve this dispute because the Court finds that Phillips' own documents established that the nine accused Driscopipe pipe products, as well as resins sold by Phillips 66 Company for use in pipe, meet the hoop stress performance criteria set forth in claim 12.

Based on the credible evidence as discussed above, the Court finds that DuPont has proved by a preponderance of the evidence that 73 accused ethylene-hexene-1 copolymers (listed in Appendix I hereto) and 9

accused Driscopipe products (Driscopipe 1000, 6300, 6400, 6500, 3300, 3400, 3700, 3800, and 3900) are within the scope of the asserted claims of the '698 patent and that defendants have infringed claims 1, 2, 5, 10, 12, and 14 of that patent.

D. Wilfulness

In anticipation of being awarded enhanced damages under 35 U.S.C. § 284 when and if this litigation reaches the damages stage, DuPont has now requested this Court to find that Phillips' infringement of the '698 patent since it was issued in 1978 was wilful.

A finding of wilfulness is a question of fact. Shiley, Inc. v. Bentley Laboratories, Inc., 794 F.2d 1561, 1568 (Fed.Cir. 1986). The Federal Circuit stated in Shatterproof Glass Corp. v. Libbey-Owen Ford Co., 758 F.2d 613, 628 (Fed.Cir. 1985), that "[t]he jurisprudence . . . uniformly requires clear and convincing evidence in support of increased damages" which this Court gathers to place this proof upon DuPont. "To wilfully infringe a patent, a patent must exist and one must have knowledge of it," and in determining wilfullness, it is necessary to look at the "totality of circumstances" presented in the case. State Industries, Inc. v. A. O. Smith Corp., 751 F.2d 1226, 1236-1237 (Fed.Cir. 1985). The Federal Circuit also stated in Paper Converting Machine v. Magna-Graphics, 745 F.2d 11, 20 (Fed.Cir. 1984), that "[a]n increase in damages for wilfulness . . . is generally inappropriate when the infringer mounts a good faith and substantial challenge to the existence of infringement." One of the circumstances for consideration in determining wilfulness is whether the infringer has established that its actions were based on "competent legal advice from

counsel" obtained "before the initiation of any possible infringing activity." Underwater Devices, Inc. v. Morrison-Knudsen Co., 717 F.2d 1380, 1389-90 (Fed.Cir. 1983); Central Soya Co., Inc. v. Geo. A. Hormel & Co., 723 F.2d 1573, 1576-77 (Fed.Cir. 1983).

With these principles in mind, the Court turns to a consideration of the totality of the circumstances of this case. DuPont's '698 patent issued in February 28, 1978. (PX 1.) Phillips was almost immediately aware of the issuance of the '698 patent because on April 20, 1978, Mr. L. N. French, associate patent counsel for Phillips, in a notegram requested J. H. Hughes and Archie Robbins, other in-house counsel for Phillips, to conduct an infringement study of the DuPont '698 patent and later a validity study was also requested. (PX 2532 at L135102; Tr. 3542.) Mr. Robbins on January 22, 1979, rendered an opinion (PX 2532), which he supplemented on March 16, 1979. (PX 2533, 2534.) Essentially these opinions acknowledged that if the '698 patent was valid and enforceable, then about 50% of Phillips' ethylene polymer production would infringe and that if claim 2 were not literally limited to 1% comonomer and a 0.95 density, all of Phillips' hexene copolymers would infringe. (PX 2532 at L135104.) Mr. Robbins also understood that an essential feature of the '698 invention was the significant improvement achieved with higher alpha-olefins over propylene and butene. (Tr. 3558-59.) Nevertheless, Mr. Robbins concluded that the '698 patent was invalid over prior art and also that the specifications and claims appeared indefinite. (Tr. 3544-45.) The prior art relied upon by Mr. Robbins to conclude invalidity was Anderson et al. '645, Belgian '782, Vandenberg '963 and Field and Feller, U.S. Patent 2,691,647. This Court has discussed the Anderson et al. '645 patent, Vandenberg '963 patent,

and the Belgian '782 patent in this opinion and arrived at a contrary opinion to that of Mr. Robbins. Phillips did not discuss the Field & Feller '647 patent in this suit. It is also noted that Mr. Robbins in concluding invalidity did not mention Phillips' own Witt and Leatherman work (Tr. 3550-51), which Professor Price, a Phillips expert, testified is the best reference against the '698 patent (Tr. 1675-76), but which the Court has found did not make the DuPont discovery. Phillips presented no evidence that outside patent counsel was asked for an opinion after it learned of the issuance of the DuPont '698 patent.

It is highly unlikely that Phillips placed much reliance on Mr. Robbins' invalidity and noninfringement opinion because in 1980 Phillips held a "Summit Meeting" to consider "the possibility of using butene rather than hexene to produce [HHM] 5502, "Phillips' largest volume ethylene-hexene copolymer. (PX 133, 1264.) The conclusion reached at that "Summit Meeting" was that it could not switch to butene because it would disrupt its marketing strategy in which it had proclaimed as a fact that hexene resins were superior to butene resins. (PX 133.) Since that meeting, Phillips has continued to promote the superior properties achieved by hexene copolymers. (PX 1242; Tr. 571-78, 3206-08.) Indeed, from 1980 to 1983 Phillips' annual sales of hexene copolymers increased from 430 million pounds to about 700 million pounds. (PX 1265.)

Phillips commenced producing hexene copolymers in 1967. (PX 1264.) Phillips first argues, relying on State Industries, Inc. v. A. O. Smith Corp., 751 F.2d 1226 (Fed. Cir. 1985), that "a finding of wilful infringement is virtually precluded by the fact that Phillips began marketing its alleged infringing products a decade before the

patent issued." (D.I. 259 at 132.) The Federal Circuit, however, shows this argument to be absolutely meritless. In Shiley, Inc. v. Bentley Laboratories, Inc., 794 F.2d 1561, 1568 (Fed.Cir. 1986), the Federal Circuit stated:

> Bentley argues that since it began to market its infringing device a month before any of Shiley's patents issued, its infringement cannot be willful as a matter of law under *State Industries, Inc. v. A.O. Smith Corp.*, 751 F.2d 1226, 224. USPQ 418 (Fed. Cir. 1985). We disagree. *State* does not, as Bentley contends, hold that a finding of willful infringement can not stand whenever manufacture of an accused device begins prior to the issuance of a patent. On the contrary, *State* is in harmony with our prior and subsequent case law, which looks to the "totality of the circumstances presented in the case," *Central Soya Co. v. George A. Hormel & Co.*, 723 F.2d 1573, 220 USPQ 490 (Fed.Cir.1983).

Phillips' second argument is that Mr. Robbins' invalidity opinions shield Phillips from a finding of wilfulness because they affirmatively demonstrate Phillips' good faith belief that it had a right to continue producing ethylene-hexene copolymers. While there were infirmities in those opinions as already pointed out, it seems quite clear that these opinions as to invalidity, indefiniteness, and possible unenforceability were not the motivating factor in 1980 to continue producing the ethylene-hexene products. Mr. Robbins and apparently no one else from the Patent Law Department attended the "Summit Meeting" (Tr. 3556) and the summary of that meeting does not discuss Mr. Robbins' patent opinions. (PX 133.) The decision not to switch to ethylene-butene copolymers and avoid possible infringement charges but stick with ethylene-hexene copolymers was a business judgment to remain competitive. Certainly the opinion played no part in that decision.

Finally, Phillips argues that the reasonableness and correctness of its good faith belief of invalidity of the '698 patent is supported by the four rejections of claims by the examiner in the reissue/reexamination proceedings which were based on the prior art which Mr. Robbins considered. This argument is not very plausible because this Court after trial has determined otherwise.

While the call of wilfulness is a close one, the Court must find that DuPont has not proved by clear and convincing evidence (*Shatterproof Glass Co., supra* at 628) that Phillips' infringement was wilful so as to support an award of enhanced damages under 35 U.S.C. § 284. On the other hand, had DuPont's burden of proof been by a preponderance of the evidence as required for infringement, this Court would find that DuPont had met that burden of proof because the evidence and interferences arising therefrom make it more likely than not that Phillips knew it was infringing despite Mr. Robbins' opinions and continued to do so purely for business reasons.

VII. CONCLUSION

Based upon the above findings of fact and conclusions of law encompassed in this opinion, the Court will enter a judgment in this case which shall: (1) deny the pretrial summary judgment motion of Phillips to dismiss this action under the doctrine of collateral estoppel based on the rejection of all claims of the '698 patent by a patent examiner entered in the reissue/reexamination proceedings in the Patent Office; (2) adjudge and declare that Phillips has not met its burden of proving by clear and convincing evidence that the DuPont '698 patent is invalid (a) based on its anticipation references under 35 U.S.C. § 102, or (b) based on obviousness under 35 U.S.C.

§ 103, or (c) based on claim indefiniteness under 35 U.S.C. § 112 (second paragraph); (3) adjudge that Phillips has not met its burden of proving that the '698 patent is unenforceable for any of the reasons advanced; (4) adjudge that DuPont has met its burden of proving by a preponderance of the evidence that the 73 accused ethylene-hexene-1 copolymers and 9 Driscopipe products are within the scope of the asserted claims of the '698 patent and that Phillips has infringed claims 1, 2, 5, 10, 12, and 14 thereof; (5) adjudge that DuPont has not met its burden of proving by clear and convincing evidence that Phillips' infringement was wilful so as to increase a damages award under 35 U.S.C. § 284; (6) enter an injunction permanently enjoining Phillips from continued infringement of the '698 patent; and (7) order an accounting to determine the damages caused by Phillips' infringement.

EXPLANATORY NOTE CONCERNING APPENDIX I AND II

In APPENDIX I and II abbreviations have been used: PX, DX, and Tr. have the same meaning as stated in Footnote 3 of the Opinion.

Levett deposition transcript page number—The deposition is found in D.I. 240 through 245.

The asterisks in APPENDIX I ("*") have the following meaning:

"*" —Value is from Phillips advertised or specification data

"**" —Value is based upon the trial testimony of Dr. Beasley

"***"—Density value corrected for presence of carbon black

Density ranges given in parenthesis—for example "(.936-.940)"—are the density specification for the feedstock resin for resins containing carbon black or other pigments.

The "Reference" under "IMPACT TOUGHNESS" is for the three preceding entries—"END USE", "ENVIRONMENTAL STRESS CRACK RESISTANCE" and "IMPACT TOUGHNESS".

Following APPENDIX I is APPENDIX II which provides a 5-page listing of ADDITIONAL EXHIBIT REFERENCES AND LEVETT DEPOSITION TRANSCRIPT REFERENCES ON INFRINGING PHILLIPS PRODUCTS, that give further record citations concerning the infringing products.

APPENDIX I

PHILLIPS MARLEX PRODUCT	HHM 4515	HHM 4520
COMONOMER	hexene-1	hexene-1
Reference:	PX 317	PX 158
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9447	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9427	.945*
Reference:	PX 1235	PX 158
3) ASTM D1928 Proc. C (Phillips)	.945	—
Reference:	DX 2704	
4) Phillips Product Specification	.942-.945	.943-.946
Reference:	PX 152	PX 154
PERCENT CRYSTALLINITY X-RAY	65.6%	70%**
Reference:	PX 1235	Tr. 390
MELT INDEX	1.5*	2.0*
Reference:	PX 317	PX 158
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.61	—
Percent Comonomer (Du Pont):	3.66%	3.8%**
Reference:	PX 1235	Tr. 391-92
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.51	—
Corrected Percent Comonomer:	3.06%	—
Reference:	DX 2704	
3) Harwood NMR Data:	2.13%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	1.97%	—
Reference:	PX 1049	
END USE	Injection Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	Excellent
IMPACT TOUGHNESS	Outstanding	Outstanding
Reference:	PX 317	PX 158
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 322-23	Tr. 392-93
Other References:	Tr. 322-24	Tr. 333-35 341,390-93

PHILLIPS MARLEX PRODUCT	HMN 4550 (or BX-470)
COMONOMER	hexene-1
Reference:	PX 164
DENSITY—Sample Preparation by:	
1) Du Pont 1955 Method	.9445
Reference:	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9420
Reference:	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.946
Reference:	DX 2704
4) Phillips Product Specification	.943-.946
Reference:	DX 2365C
PERCENT CRYSTALLINITY X-RAY	70.5%
Reference:	PX 1235
MELT INDEX	5*
Reference:	PX 164
Fluff Melt Index	—
Reference:	
PERCENT COMONOMER (BY WEIGHT)	
1) Methyl Groups Per 100 Carbons:	0.70
Percent Comonomer (Du Pont):	4.20%
Reference:	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—
Corrected Percent Comonomer:	—
Reference:	
3) Harwood NMR Data:	2.44%
Reference:	DX 2704
4) Phillips (Hsieh) NMR Data:	2.73, 2.47%
Reference:	PX 1050, DX 2170
END USE	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	—
IMPACT TOUGHNESS	Outstanding
Reference:	PX 164
CLAIMS INFRINGED	2, 5
Reference:	Tr. 393-94
Other References:	Tr. 393-95

PHILLIPS MARLEX PRODUCT	HHM 4903	HHM 4903-01
COMONOMER	hexene-1	hexene-1
Reference:	PX 168	PX 166
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9481	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9475	.947-.950*
Reference:	PX 1235	PX 166
3) ASTM D1928 Proc. C (Phillips)	.950	—
Reference:	DX 2704	
4) Phillips Product Specification	.947-.950	.947-.950
Reference:	DX 2365C	PX 166
PERCENT CRYSTALLINITY X-RAY	74.1%	74%**
Reference:	PX 1235	Tr. 398
MELT INDEX	0.3*	0.30-0.40*
Reference:	PX 168	PX 166
Fluff Melt Index	0.45-0.60	0.50-0.60
Reference:	PX 634	PX 634
	L124615	L124615
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.33	—
Percent Comonomer (Du Pont):	1.98%	2.0%**
Reference:	PX 1235	Tr. 398
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.23	—
Corrected Percent Comonomer:	1.38%	—
Reference:	DX 2704	
3) Harwood NMR Data:	1.22%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	1.16%	—
Reference:	DX 2171	
END USE	Injection Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional	Exceptional
IMPACT TOUGHNESS	—	—
Reference:	PX 168	PX 168
CLAIMS INFRINGED	2, 5, 10	2, 5, 10
Reference:	Tr. 396-97	Tr. 398, 401-02
Other References:	Tr. 396-97	Tr. 397-402

PHILLIPS MARLEX PRODUCT	HMN 5060 (or BX-573)	HHM 5202
COMONOMER	hexene-1	hexene-1
Reference:	PX 318	PX 188
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9491	.9504
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9476	.9497
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.951	.952
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.948-.951	.949-.952
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	74.1%	74.3%
Reference:	PX 1235	PX 1235
MELT INDEX	6*	0.35*
Reference:	PX 318	PX 188
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.59	0.22
Percent Comonomer (Du Pont):	3.54%	1.32%
Reference:	PX 1235	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	0.14
Corrected Percent Comonomer:	—	0.84%
Reference:		DX 2704
3) Harwood NMR Data:	1.54%	0.69%, 0.79%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	1.5%	0.71%
Reference:	DX 2136	DX 2172
END USE	Injection Molding	Blow Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	High	Excellent
IMPACT TOUGHNESS	Good	Good
Reference:	PX 318	PX 188
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 402	Tr. 402
Other References:	Tr. 402	Tr. 402

PHILLIPS MARLEX PRODUCT	HHM 5202-01	HHM 5202-02-LD
COMONOMER	hexene-1	hexene-1
Reference:	PX 187	PX 634
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9513
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.949-.952*	.9508
Reference:	PX 187	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.953
Reference:		DX 2704
4) Phillips Product Specification	.949-.952	.949-.952
Reference:	PX 187	PX 634 L124671
PERCENT CRYSTALLINITY X-RAY	74%**	74.8%
Reference:	Tr. 403	PX 1235A
MELT INDEX	0.20-0.29*	0.25-0.35*
Reference:	PX 187	PX 634 L124671
Fluff Melt Index	greater than .3	—
Reference:	Tr. 418	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	0.27
Percent Comonomer (Du Pont):	1.3%**	1.62%
Reference:	Tr. 403	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	0.19
Corrected Percent Comonomer:	—	1.14%
Reference:		DX 2704
3) Harwood NMR Data:	—	0.48%
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Blow Molding	Blow Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	Excellent
IMPACT TOUGHNESS	Good	Good
Reference:	PX 188	PX 188
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 403, 417-18	Tr. 405-06
Other References:	Tr. 402-03, 417-18	Tr. 403-06

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PHILLIPS MARLEX PRODUCT	HHM 5502	HHM 5502-LD
COMONOMER	hexene-1	hexene-1
Reference:	PX 378	PX 199
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9516	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9521	.955*
Reference:	PX 1235	PX 199
3) ASTM D1928 Proc. C (Phillips)	.956	—
Reference:	DX 2704	
4) Phillips Product Specification	.953-.956	.953-.956
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	79.2%	79%**
Reference:	PX 1235	Tr. 408
MELT INDEX	0.35*	0.35*
Reference:	PX 378	PX 199
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.14	—
Percent Comonomer (Du Pont):	0.84%	1.0%**
Reference:	PX 1235A	Tr. 408
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.06	—
Corrected Percent Comonomer:	0.36%	—
Reference:	DX 2704	
3) Harwood NMR Data:	0.45, 0.48, 0.52%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	0.38 to 0.57%	0.48%
Reference:	DX 2173 to 2177	DX 2178
END USE	Blow Molding	Blow Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional	Exceptional
IMPACT TOUGHNESS	—	—
Reference:	PX 378	PX 199
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 407-08	Tr. 408-09
Other References:	Tr. 406-08	Tr. 408-09

PHILLIPS MARLEX PRODUCT	HH-M 5502-01	HHM 5502-02-LD
COMONOMER	hexene-1	hexene-1
Reference:	PX 193	PX 193
DENSITY--Sample Preparation by:		
1) Du Pont 1955 Method	.9540	.9532
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9539	.9536
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.956	.957
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.953-.956	.953-.956
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	78.3%	77.3%
Reference:	PX 1235	PX 1235*
MELT INDEX	0.20-0.29*	0.25-0.35*
Reference:	PX 193	PX 193
Fluff Melt Index	0.46-0.56	0.50-0.60
Reference:	PX 634 L124617	PX 634 L124617
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.14	0.21
Percent Comonomer (Du Pont):	0.84%	1.26%
Reference:	PX 1235	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.06	0.13
Corrected Percent Comonomer:	0.36%	0.78%
Reference:	DX 2704	DX 2704
3) Harwood NMR Data:	0.42%	0.48%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Blow Molding	Blow Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional	Exceptional
IMPACT TOUGHNESS	—	—
Reference:	PX 378	PX 199
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 411, 415-16	Tr. 414-15
Other References:	Tr. 410-11, 415-16	Tr. 414-15

PHILLIPS MARLEX PRODUCT	HHM 5502-03	HMN 54140 (or BX-574)
COMONOMER	hexene-1	hexene-1
Reference:	PX 193	PX 202
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9543
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.953-.956*	.9543
Reference:	PX 193	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.956
Reference:		DX 2704
4) Phillips Product Specification	.953-.956	.951-.954
Reference:	PX 193	DX 2365C
PERCENT CRYSTALLINITY X-RAY	77%**	80.9%
Reference:	Tr. 418	PX 1235A
MELT INDEX	0.30-0.40*	14*
Reference:	PX 193	PX 202
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	0.41
Percent Comonomer (Du Pont):	1.3%**	2.46%
Reference:	Tr. 418	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	0.96%
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	1.4%, 1.2%
Reference:		PX 1060, PX 1061
END USE	Blow Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional	—
IMPACT TOUGHNESS	—	Good
Reference:	PX 378	PX 202
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 419	Tr. 419-20
Other References:	Tr. 418-19	Tr. 419-20

PHILLIPS MARLEX PRODUCT	HMN 5550	HMN 5580 (or BX-572)
COMONOMER	hexene-1	hexene-1
Reference:	PX 205	PX 209
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9513
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.955*	.9512
Reference:	PX 205	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.956
Reference:		DX 2704
4) Phillips Product Specification	.953-.956	.953-.956
Reference:	PX 207	DX 2356C
PERCENT CRYSTALLINITY X-RAY	79%**	78.1%
Reference:	Tr. 420	PX 1235
MELT INDEX	5.0*	8*
Reference:	PX 205	PX 209
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	0.34
Percent Comonomer (Du Pont):	2.0%**	2.04%
Reference:	Tr. 420-21	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	0.72%
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	1.2%
Reference:		PX 1059
END USE	Injection Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Good	Good
Reference:	PX 205	PX 209
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 421-22	Tr. 423
Other References:	Tr. 420-22	Tr. 423

PHILLIPS MARLEX PRODUCT	HHN 5710 (or GX-571)	HMN 6060 (or BX-672)
COMONOMER	hexene-1	hexene-1
Reference:	PX 319	PX 272
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9480	.9589
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9454	.9601
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.951	.964
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.954-.957	.960-.963
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	73.4%	85.2%
Reference:	PX 1235A	PX 1235
MELT INDEX	1.0*	6.5*
Reference:	PX 319	PX 272
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.14	0.16
Percent Comonomer (Du Pont):	0.84%	0.96%
Reference:	PX 1235A	PX 1235A
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	0.75%	0.45%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	0.02 mole %	0.10%
Reference:	DX 2180	DX 2181
END USE	Multi-Purpose	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Good
Reference:	PX 319	PX 272
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 453-54	Tr. 424-25
Other References:	Tr. 453-54	Tr. 424-25

PHILLIPS MARLEX PRODUCT	HHM TR-100 (7.5% Elastomer)	HHM TR-102 (30% Elastomer)
COMONOMER	hexene-1	hexene-1
Reference:	PX 213	PX 264
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.947*	.939*
Reference:	PX 213	PX 264
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	92.5% HHM 4903	70% HHM 4903 or D-506
Reference:	PX 237	PX 263
PERCENT CRYSTALLINITY X-RAY	—	—
Reference:		
MELT INDEX	0.30*	0.30*
Reference:	PX 213	PX 264
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)	See HHM 4903	See HHM 4903 and HHM TR-150
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	—	—
Reference:		
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Film	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Excellent
Reference:	PX 213	PX 264
CLAIMS INFRINGED	2, 5, 10	2, 5, 10
Reference:	Tr. 450	Tr. 451-52
Other References:	Tr. 448-50	Tr. 450-52

PHILLIPS MARLEX PRODUCTS	HHM TR-130 (or D-320)	HHM TR-140 (or D-420)
COMONOMER	hexene-1	hexene-1
Reference:	PX 320	PX 284
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9377	.9444
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9356	.9439
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.939	.946
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.935-.939	.944-.947
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	66.2%	72.5%
Reference:	PX 1235	PX 1235
MELT INDEX	0.28*	0.28%*
Reference:	PX 320	PX 379
Fluff Melt Index	0.35-0.45	0.40-0.50
Reference:	PX 634	PX 634
	L124620	L124622
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.86	0.44
Percent Comonomer (Du Pont):	5.16%	2.64%
Reference:	PX 1235	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.77	0.35
Corrected Percent Comonomer:	4.62%	2.10%
Reference:	DX 2704	DX 2704
3) Hardwood NMR Data:	3.45%	1.46%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	2.8, 3.8, 3.37%	1.35, 1.34%
Reference:	DX 2148, PX1037 PX 1038	DX 2152, PX 1041
END USE	Film	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Excellent
Reference:	PX 320	PX 379
CLAIMS INFRINGED	1,2,5,10,14	2,5,10,14
Reference:	Tr. 426-29	Tr. 429-30
Other References:	Tr. 426-29	Tr. 429-30

PHILLIPS MARLEX PRODUCT	HHM TR-144 (or D-422)	HHM TR-150 (or D-506)
COMONOMER	hexene-1	hexene-1
Reference:	PX 379	PX 261
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9460	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9442	.949*
Reference:	PX 1235	PX 261
3) ASTM D1928 Proc. C (Phillips)	.948	—
Reference:	DX 2704	
4) Phillips Product Specification	.944-.947	.947-.950
Reference:	DX 2365C	PX 259
PERCENT CRYSTALLINITY X-RAY	71.9%	74%**
Reference:	PX 1235	Tr. 431
MELT INDEX	0.18*	0.30*
Reference:	PX 379	PX 261
Fluff Melt Index	greater than .3	—
Reference:	Tr. 521-22	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.42	—
Percent Comonomer (Du Pont):	2.52%	2.0%**
Reference:	PX 1235	Tr. 431
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.32	—
Corrected Percent Comonomer:	1.72%	—
Reference:	DX 2704	
3) Hardwood NMR Data:	1.58%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	1.4%	—
Reference:	DX 2154	
END USE	Film	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Good
Reference:	PX 379	PX 261
CLAIMS INFRINGED	2, 5, 10	2, 5, 10
Reference:	Tr. 430, 519-22 PX 379	Tr. 431-32
Other References:	Tr. 430, 519-22	Tr. 431-32

PHILLIPS MARLEX PRODUCT	HHM TR-210 (or J-440)	HHM TR-226 (or J-426)
COMONOMER	hexene-1	hexene-1
Reference:	PX 291	PX 298
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9432	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9391	.944*
Reference:	PX 1235	PX 298
3) ASTM D1928 Proc. C (Phillips)	.944	—
Reference:	DX 2704	
4) Phillips Product Specification	.941-.944	(.942-.945)
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	68.9%	66%**
Reference:	PX 1235	Tr. 433
MELT INDEX	0.85*	1.5*
Reference:	PX 291	PX 298
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.62	—
Percent Comonomer (Du Pont):	3.72%	3.5%**
Reference:	PX 1235	Tr. 433
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.52	—
Corrected Percent Comonomer:	3.12%	—
Reference:	DX 2704	
3) Harwood NMR Data:	2.47%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	2.0%	—
Reference:	DX 2704	
END USE	Wire Coating	Wire Coating
ENVIRONMENTAL STRESS CRACK RESISTANCE	Meets Western Electric Std. MS 590622 and REA Std. PE 200, Appp. C	Excellent
IMPACT TOUGHNESS	—	—
Reference:	PX 291	PX 298
CLAIMS INFRINGED	2, 5,14	2, 5, 14
Reference:	Tr. 454-55	Tr. 434
Other References:	Tr. 454-55	Tr. 432-34

PHILLIPS MARLEX PRODUCT	HHM TR-230 Black (or J-320 or J-339)	HHM TR-232 Black (or J-322)
COMONOMER	hexene-1	hexene-1
Reference:	PX 349, PX 350	PX 353
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9508	.9502
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9487	.9475
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.941***	.943***
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.945-.952 (.935-.938)	.949-.956 (.936-.940)
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	66%**	66%**
Reference:	Tr. 436	Tr. 441
MELT INDEX	0.5*	0.20*
Reference:	PX 349, Px 350	PX 353
Fluff Melt Index	0.60-0.70 (.30-.45 for J-320)	0.40-0.50
Reference:	PX 344, PX 220	PX 219
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	5.0%**	5.0%**
Reference:	Tr. 436	Tr. 441
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	3.36%	2.92%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Wire Coating	Wire Coating
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent** Tr. 437, PX 350	Excellent
IMPACT TOUGHNESS	Excellent	—
Reference:	PX 349, PX 350	PX 353
CLAIMS INFRINGED	2, 5, 14	1, 2, 5, 14
Reference:	Tr. 437, 440	Tr. 442
Other References:	Tr. 434-40	Tr. 440-42

PHILLIPS MARLEX PRODUCT	HHM TR-232 Yellow (or J-325)	HHM TR-236 Black
COMONOMER	hexene-1	hexene-1
Reference:	Levett 515-16	Levett 434
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9448	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9430	.950*
Reference:	PX 1235	PX 304
3) ASTM D1928 Proc. C (Phillips)	.946	—
Reference:	PX 2704	
4) Phillips Product Specification	.941-.949 (.936-.940)	.949-.953 PX 303
Reference:	DX 2365C	
PERCENT CRYSTALLINITY X-RAY	65.8%	68%**
Reference:	PX 1235	Tr. 459
MELT INDEX	0.15-0.35*	0.70*
Reference:	PX 356	PX 304
Fluff Melt Index	0.40-0.50	—
Reference:	PX 219	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.94	—
Percent Comonomer (Du Pont):	5.64%	4.0%**
Reference:	PX 1235	Tr. 459-60
2) Corrected Methyl Groups	0.86	—
Per 100 Carbons (Phillips):	5.16%	—
Corrected Percent Comonomer:	DX 2704	
Reference:		
3) Harwood NMR Data:	3.37%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Wire Coating	Pipe
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	—
IMPACT TOUGHNESS	—	Excellent
Reference:	PX 353	PX 304
CLAIMS INFRINGED	1, 2, 5, 14	2, 5
Reference:	Tr. 446	Tr. 460-61
Other References:	Tr. 443-46	Tr. 458-61

PHILLIPS MARLEX PRODUCT	HHM TR-250 Black (or J-510)	HHM TR-257 (or J-517)
COMONOMER	hexene-1	hexene-1
Reference:	PX 307	Levett 441-43
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9594	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9580	.947-.949*
Reference:	PX 1235	PX 309
3) ASTM D1928 Proc. C (Phillips)	.953***	—
Reference:	DX 2704	
4) Phillips Product Specification	.958-.965 (.947-.950)	.947-.949
Reference:	DX 2365C	PX 309
PERCENT CRYSTALLINITY X-RAY	74%**	74%**
Reference:	Tr. 461	Tr. 466
MELT INDEX	0.2*	0.18-0.27*
Reference:	PX 307	PX 309
Fluff Melt Index	Made from HHM 4903	greater than .3
Reference:	PX 306	Tr. 466-67
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	2.0%**	2.0%**
Reference:	Tr. 464-65	Tr. 466
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	1.17%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Wire Coating	Wire Coating**
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	Exceptional**
IMPACT TOUGHNESS	—	—
Reference:	PX 307	Tr. 526-27
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 462-66	Tr. 467
Other References:	Tr. 461-66	Tr. 466-67

PHILLIPS MARLEX PRODUCT	HHM TR-400 (or H-310)	HHM TR-401 (or H-460)
COMONOMER	hexene-1	hexene-1
Reference:	PX 312	PX 315
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9390	.9428
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9372	.9403
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.939	.943
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.936-.940	.942-.945
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	66.4%	71.4%
Reference:	PX 1235	PX 1235
MELT INDEX	0.25*	0.25*
Reference:	PX 312	PX 315
Fluff Melt Index	0.35-0.45	0.30-0.45
Reference:	PX 634	PX 634
	L124623	L124625
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.78	0.61
Percent Comonomer (Du Pont):	4.68%	3.66%
Reference:	PX 1235A	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.69	0.52
Corrected Percent Comonomer:	4.14%	3.12%
Reference:	DX 2704	DX 2704
3) Harwood NMR Data:	2.94%	2.08%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	2.71%	1.81, 1.79, 1.87%
Reference:	DX 2156	DX 2157, PX 1045, PX 1046
END USE	Pipe	Pipe
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding	Outstanding
IMPACT TOUGHNESS	—	—
Reference:	PX 312	PX 315
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 468	Tr. 469
Other References:	Tr. 467-68	Tr. 468-69

PHILLIPS MARLEX PRODUCT	HHM TR-415 Black	HHM TR-416 Black
COMONOMER	hexene-1	hexene-1
Reference:	PX 1232	PX 329
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9551
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.956*	.9526
Reference:	PX 1232	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.946***
Reference:		DX 2704
4) Phillips Product Specification	.952-.959	.952-.959
Reference:	(.941-9.44) PX 323, PX 324	(.941-.944) DX 2365C
PERCENT CRYSTALLINITY X-RAY	72%**	72%**
Reference:	Tr. 469-70	Tr. 472
MELT INDEX	0.30*	0.30*
Reference:	PX 1232	PX 329
Fluff Melt Index	0.45-0.65	0.40-0.55
Reference:	PX 324	PX 327
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	3.5%**	3.5%**
Reference:	Tr. 470	Tr. 472
2) Corrected Methyl Groups	—	—
Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	2.08%
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Pipe (Levett 464-65)	Electrical Conduit
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	Good
IMPACT TOUGHNESS	Excellent	—
Reference:	PX 1232	PX 329
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 470-71	Tr. 472
Other References:	Tr. 469-71	Tr. 472

PHILLIPS MARLEX PRODUCT	HHM TR-418 Black	HHM TR-418 Orange
COMONOMER	hexene-1	hexene-1
Reference:	PX 224	PX 233
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9499	.9409
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9467	.9381
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.941***	.941
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.944-.956 (.936-.940)	.938-.942 (.936-.940)
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	67%**	66.7%
Reference:	Tr. 473	PX 1235
MELT INDEX	0.30*	0.20*
Reference:	PX 224	PX 233
Fluff Melt Index	0.40-0.55	0.25-0.35
Reference:	PX 219	PX 232
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	0.82
Percent Comonomer (Du Pont):	5.0%**	4.92%
Reference:	Tr. 473	PX 1235
2) Corrected Methyl Groups	—	0.73
Per 100 Carbons (Phillips):	—	4.33%
Corrected Percent Comonomer:		DX 2704
Reference:		
3) Harwood NMR Data:	3.31%	3.01%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	—	2.62, 2.87%
Reference:		DX 2160, DX 2161
END USE	Pipe	Pipe
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding-Exceeds ASTM Requirements for Pipe Compounds	Outstanding-Exceeds ASTM Requirements for Pipe Compounds
IMPACT TOUGHNESS	—	—
Reference:	PX 224	PX 233
CLAIMS INFRINGED	1,2,5,14	1, 2, 5, 14
Reference:	Tr. 473-75	Tr. 476-77
Other References:	Tr. 472-75	Tr. 475-77

PHILLIPS MARLEX PRODUCT	728 Fluff	728-01
COMONOMER	hexene-1	hexene-1
Reference:	PX 634, PX 231	PX 231, Levett 114-15
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9366	.9369
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9366	.9366
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.938	.938
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.936-.940	.936-.940
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	66.7%	66.8%
Reference:	PX 1235	PX 1235
MELT INDEX	0.25-0.35*	0.33
Reference:	PX 232	PX 1235
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.84	0.90
Percent Comonomer (Du Pont):	5.04%	5.40%
Reference:	PX 1235A	PX 1235A
2) Corrected Methyl Groups	0.75	0.81
Per 100 Carbons (Phillips):	4.50%	4.86%
Corrected Percent Comonomer:	DX 2704	DX 2704
Reference:		
3) Harwood NMR Data:	3.60%	3.80%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Base Resin For HHM TR-418 Orange and White	Base Resin For HHM TR-418**
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding-Exceeds ASTM Requirements For Pipe Compounds	Outstanding-Exceeds ASTM Requirements For Pipe Compounds**
IMPACT TOUGHNESS	—	—
Reference:	PX 233, PX 231	PX 233, PX 231 Levett 114-15
CLAIMS INFRINGED	1, 2, 5,14	1, 2, 5,14
Reference:	Tr. 477	Tr. 477-78
Other References:	Tr. 477	Tr. 477-78

PHILLIPS MARLEX PRODUCT	HHM TR-418 White	HHM TR-418 Yellow
COMONOMER	hexene-1	hexene-1
Reference:	PX 237	PX 238
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.938-.942*	.938-.942*
Reference:	PX 232	PX 220, PX 221
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.938-.942	.938-.942
Reference:	PX 232	PX 220, PX 221
PERCENT CRYSTALLINITY X-RAY	67%**	67%**
Reference:	Tr. 478	Tr. 480
MELT INDEX	0.15-0.25*	0.15-0.25*
Reference:	PX 237	PX 238
Fluff Melt Index	0.25-0.35	0.24-0.34
Reference:	PX 232	PX 220
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	5.0%**	5.0%**
Reference:	Tr. 478	Tr. 480
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Pipe	Pipe
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding-Exceeds ASTM Requirements For Pipe Compounds	Outstanding-Exceeds ASTM Requirements For Pipe Compounds
IMPACT TOUGHNESS	—	—
Reference:	PX 233	PX 233, PX 220
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 479	Tr. 480
Other References:	Tr. 478-79	Tr. 480

PHILLIPS MARLEX PRODUCT	HHM TR-418-01 Orange	HHM TR-460 Orange
COMONOMER	hexene-1	hexene-1
Reference:	Levett 566	Levett 336
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.938-.942*	.944*
Reference:	PX 383	PX 336
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.938-.942 (.936-.940)	.942 min. (.942-.945)
Reference:	PX 383, PX 219	PX 333, PX 334
PERCENT CRYSTALLINITY X-RAY	67%**	67%**
Reference:	Tr. 481	Tr. 482
MELT INDEX	0.15-0.25*	0.25*
Reference:	PX 383	PX 336
Fluff Melt Index	From H-328F	0.42-0.58
Reference:	PX 383	PX 334
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	5.0%**	3.0%**
Reference:	Tr. 481	Tr. 482-83
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Pipe	Pipe
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding-Exceeds ASTM Requirements For Pipe Compounds	High
IMPACT TOUGHNESS	—	—
Reference:	PX 233, PX 220	PX 336
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 481-81A	Tr. 482-83A
Other References:	Tr. 481-81A	Tr. 482-83A

PHILLIPS MARLEX PRODUCT	HHM TR-480 Black	HMN TR-938 (or LX-471)
COMONOMER	hexene-1	hexene-1
Reference:	PX 339	PX 322
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9555	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9531	.938*
Reference:	PX 1235	PX 322
3) ASTM D1928 Proc. C (Phillips)	.948***	—
Reference:	DX 2704	
4) Phillips Product Specification	.952 min. (.942-.945)	.937-.940 DX 2365C
Reference:	DX 2365C	
PERCENT CRYSTALLINITY X-RAY	67%**	66%**
Reference:	Tr. 484	Tr. 486
MELT INDEX	0.25*	3.0*
Reference:	PX 339	PX 322
Fluff Melt Index	0.42-0.58	—
Reference:	PX 334	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	3.0%**	5.7%**
Reference:	Tr. 484	Tr. 486
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:		
Reference:		
3) Harwood NMR Data:	2.04%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	3.825%
Reference:		DX 2163
END USE	Pipe	Rotational Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	High**	Excellent
	Tr. 527-30	
IMPACT TOUGHNESS	—	Excellent
Reference:	PX 339	PX 322
CLAIMS INFRINGED	2, 5, 14	2, 5
Reference:	Tr. 484	Tr. 486-87
Other References:	Tr. 484, 527-30	Tr. 484-87

PHILLIPS MARLEX PRODUCT	HMN TR-938 JV	HMN TR-942 JV
COMONOMER	hexene-1	hexene-1
Reference:	PX 322	PX 361
DENSITY—Sample Preparation by:		
1) Du Pont 1955 Method	.9396	.9417
Reference:	PX 1235	PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.9376	.9395
Reference:	PX 1235	PX 1235
3) ASTM D1928 Proc. C (Phillips)	.940	.944
Reference:	DX 2704	DX 2704
4) Phillips Product Specification	.937-.940	.941-.944
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	65.5%	68.3%
Reference:	PX 1235	PX 1235
MELT INDEX	3.0*	3.0*
Reference:	PX 322	PX 361
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.95	0.72
Percent Comonomer (Du Pont):	5.70%	4.32%
Reference:	PX 1235	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	3.69%	2.85%
Reference:	DX 2704	DX 2704
4) Phillips (Hsieh) NMR Data:	3.77%, 3.54%	2.44%
Reference:	PX 483, DX 2165	DX 2166
END USE	Rotational Molding	Rotational Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	Excellent
IMPACT TOUGHNESS	Excellent	Excellent
Reference:	PX 322	PX 361
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 487-88	Tr. 488, 490
Other References:	Tr. 487-88	Tr. 488, 490

PHILLIPS MARLEX PRODUCT	HMN TR-942 (or LX-470)	HMN TR-950 (or LX-571)
COMONOMER	hexene-1	hexene-1
Reference:	PX 361	PX 368
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.942*	.950*
Reference:	PX 361	PX 368
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.941-.944	From HMN 5060
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	69%**	74**%
Reference:	Tr. 489	Tr. 491
MELT INDEX	3.0*	5*
Reference:	PX 361	PX 368
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	4.0%**	3.5%**
Reference:	Tr. 489	Tr. 495
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	2.37%	—
Reference:	DX 2167	
END USE	Rotational Molding	Rotational Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	Excellent	Good
IMPACT TOUGHNESS	Excellent	Good
Reference:	PX 361	PX 368
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 489	Tr. 491-92, 495
Other References:	Tr. 488-89	Tr. 490-92, 495

PHILLIPS MARLEX PRODUCT	HMN TR-954 (or LX-570)	DTR
COMONOMER	hexene-1	hexene-1
Reference:	PX 371	Levett 334-35, 537
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9539
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.955*	.9536
Reference:	PX 371	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.957
Reference:		DX 2704
4) Phillips Product Specification	From HMN 5580	.953-.958
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	78.1**	79.6%
Reference:	Tr. 493	PX 1235
MELT INDEX	8*	0.20-0.45*
Reference:	PX 371	PX 374
Fluff Melt Index	—	0.40-0.90
Reference:		PX 375
PERCENT COMONOMER (BY WEIGHT)	From HMN 5580	
1) Methyl Groups Per 100 Carbons:	—	0.16
Percent Comonomer (Du Pont):	2.0%**	0.96%
Reference:	Tr. 493	PX 1235
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	0.06
Corrected Percent Comonomer:	—	0.36%
Reference:		DX 2704
3) Harwood NMR Data:	—	0.39%
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Rotational Molding	Drain Tile Levett 334-35
ENVIRONMENTAL STRESS CRACK RESISTANCE	Good	Exceptional**
IMPACT TOUGHNESS	Good	—
Reference:	PX 371	Tr. 523-24
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 494	Tr. 496-97
Other References:	Tr. 493-94	Tr. 496-97, 523-24

PHILLIPS MARLEX PRODUCT	DTR-01	D-510
COMONOMER	hexene-1	hexene-1
Reference:	Levett 334-35, 537	PX 212, PX 168 PX 215
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9500	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9538	.947-.950*
Reference:	PX 1235	PX 212, PX 166
3) ASTM D1928 Proc. C (Phillips)	.956	—
Reference:	DX 2704	
4) Phillips Product Specification	.954-.957	HHM 4903 Film
Reference:	DX 2365C	Grade PX 212
PERCENT CRYSTALLINITY X-RAY	78.2%	74%**
Reference:	PX 1235	Tr. 502
MELT INDEX	0.15-0.30*	0.20-0.35*
Reference:	PX 374	PX 212, PX 166
Fluff Melt Index	greater than .3	See HHM 4903
Reference:	Tr. 498-99	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.14	--
Percent Comonomer (Du Pont):	0.84%	2.0%**
Reference:	PX 1235	Tr. 502
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.06	—
Corrected Percent Comonomer:	0.36%	—
Reference:	DX 2704	
3) Harwood NMR Data:	0.48%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Drain Tile	Film
	Levett 334-35	
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional**	Excellent
IMPACT TOUGHNESS	—	—
Reference:	Tr. 523-24	PX 212, PX 168
CLAIMS INFRINGED	2, 5	2, 5, 10
Reference:	Tr. 498-501	Tr. 502-03
Other References:	Tr. 498-501, 523-24	Tr. 501-03

PHILLIPS MARLEX PRODUCT	H-328	J-425
COMONOMER	hexene-1	hexene-1
Reference:	PX 230	PX 301
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.936-.940*	.942-.945*
Reference:	PX 219	PX 297
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.936-.940	.942-.945
Reference:	PX 219	PX 297
PERCENT CRYSTALLINITY X-RAY	66%**	67%**
Reference:	Tr. 503	Tr. 504
MELT INDEX	0.25-0.43*	0.30-1.7%*
Reference:	PX 232	PX 297
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	5.0%	3.0%**
Reference:	Tr. 503	Tr. 505
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Predecessor to 728 Feedstock	Feedstock to HHM TR-226
ENVIRONMENTAL STRESS CRACK RESISTANCE	Outstanding	Excellent
IMPACT TOUGHNESS	—	—
Reference:	PX 231, PX 232, PX 233	PX 296, PX 297, PX 298
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 504	Tr. 506-07
Other References:	Tr. 503-04	Tr. 504-07

PHILLIPS MARLEX PRODUCT	BX-575	BX-579
COMONOMER	hexene-1	hexene-1
Reference:	PX 396	PX 398
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9538	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9525	.955*
Reference:	PX 1235	PX 398
3) ASTM D1928 Proc. C (Phillips)	.956	—
Reference:	DX 2704	
4) Phillips Product Specification	.954-.956	.953-.956
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	80.5%	82%**
Reference:	PX 1235	Tr. 540
MELT INDEX	18*	10.5*
Reference:	PX 396	PX 398
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.51	—
Percent Comonomer (Du Pont):	3.06%	2.5%**
Reference:	PX 1235	Tr. 540-41
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	0.90%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	1.47%	—
Reference:	PX1062	
END USE	Injection Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Good
Reference:	PX 396	PX 398
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 528-39	Tr. 541
Other References:	Tr. 538-39	Tr. 540-41

PHILLIPS MARLEX PRODUCT	BX-671JX (or BX-671)	BX-673
COMONOMER	hexene-1	hexene-1
Reference:	PX 401	PX 404
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9593	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9590	.960*
Reference:	PX 1235	PX 404
3) ASTM D1928 Proc. C (Phillips)	.962	—
Reference:	DX 2704	
4) Phillips Product Specification	.958-.961	.958-.961
Reference:	DX 2365C	DX 2365C
PERCENT CRYSTALLINITY X-RAY	83.9%	84%**
Reference:	PX 1235	Tr. 542
MELT INDEX	12*	12*
Reference:	PX 401	PX 404
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.35	—
Percent Comonomer (Du Pont):	2.1%	2.1%**
Reference:	PX 1235	Tr. 542
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	0.48%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Injection Molding	Injection Molding
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Good	Good
Reference:	PX 401	PX 404
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 541	Tr. 543
Other References:	Tr. 541-42	Tr. 542-43

PHILLIPS MARLEX PRODUCT	C-551	C-552-LD
COMONOMER	hexene-1	hexene-1
Reference:	Levett 600	Levett 554
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.953-.956*	.953-.956*
Reference:	PX 406	PX 381
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.953-.956	.953-.956
Reference:	PX 406	PX 381
PERCENT CRYSTALLINITY X-RAY	78%**	77%**
Reference:	Tr. 544	Tr. 546
MELT INDEX	0.18-0.28*	0.36-0.45*
Reference:	PX 406	PX 381
Fluff Melt Index	greater than .3	—
Reference:	Tr. 545	
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	0.8%**	1.3%**
Reference:	Tr. 544	Tr. 546
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Blow Molding**	Blow Molding
		Levett Tr. 556
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional**	Excellent**
IMPACT TOUGHNESS	—	—
Reference:	Tr. 530-31	Tr. 532-33
CLAIMS INFRINGED	2, 5	2, 5
Reference:	Tr. 544-46	Tr. 547
Other References:	Tr. 543-46, 530-31	Tr. 546-47, 532-33

PHILLIPS MARLEX PRODUCT	C-555	D-310 (or M-320)
COMONOMER	hexene-1	hexene-1
Reference:	PX 411	PX 413
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C(Du Pont)	.955*	.939*
Reference:	PX 411	PX 413
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.953-.956	.936-.940
Reference:	PX 409	PX 412
PERCENT CRYSTALLINITY X-RAY	77%**	66%**
Reference:	Tr. 547	Tr. 549
MELT INDEX	0.35*	0.22*
Reference:	PX 411	PX 413
Fluff Melt Index	0.45-0.60	0.37-0.57
Reference:	PX 634 L124619	PX 414
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:		
Percent Comonomer (Du Pont):	1.3%**	5.0%**
Reference:	Tr. 547-48	Tr. 349-50
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Blow Molding	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	Exceptional	—
IMPACT TOUGHNESS	—	Excellent
Reference:	PX 411	PX 413
CLAIMS INFRINGED	2, 5	2, 5, 10, 14
Reference:	Tr. 548-49	Tr. 550-53
Other References:	Tr. 547-49	Tr. 549-53

PHILLIPS MARLEX PRODUCT	D-321	D-442
COMONOMER	hexene-1	hexene-1
Reference:	PX 421	Levett 629
DENSITY—Sample Preparation by:		NO SAMPLE
1) Du Pont 1955 Method	.9367	—
Reference:	PX 1235	
2) ASTM D1928 Proc. C (Du Pont)	.9373	.944-.947*
Reference:	PX 1235	PX 442
3) ASTM D1928 Proc. C (Phillips)	.939	—
Reference:	DX 2704	
4) Phillips Product Specification	.935-.939	.944-.947
Reference:	DX 2365C	PX 422
PERCENT CRYSTALLINITY X-RAY	65.5%	73%**
Reference:	PX 1235A	Tr. 553
MELT INDEX	0.30*	0.23-0.33*
Reference:	PX 421	PX 422
Fluff Melt Index	—	greater than .3
Reference:		Tr. 554
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	0.80	—
Percent Comonomer (Du Pont):	4.80%	3.0%**
Reference:	PX 1235	Tr. 553
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	0.69	—
Corrected Percent Comonomer:	4.1%	—
Reference:	DX 2704	
3) Harwood NMR Data:	3.40%	—
Reference:	DX 2704	
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Film	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Excellent	Excellent**
Reference:	PX 421	PX 422, Tr. 533-34
CLAIMS INFRINGED	2, 5, 10, 14	2, 5, 10, 14
Reference:	Tr. 551-52	Tr. 554-55
Other References:	Tr. 551-52	Tr. 553-55

PHILLIPS MARLEX PRODUCT	D-521	DX-611
COMONOMER	hexene-1	hexene-1
Reference:	PX 426	PX 1233
DENSITY—Sample Preparation by:	NO SAMPLE	
1) Du Pont 1955 Method	—	.9597
Reference:		PX 1235
2) ASTM D1928 Proc. C (Du Pont)	.958*	.9604
Reference:	PX 426	PX 1235
3) ASTM D1928 Proc. C (Phillips)	—	.964
Reference:		DX 2704
4) Phillips Product Specification	.954-.957	.960-.963
Reference:	PX 424	DX 2365C
PERCENT CRYSTALLINITY X-RAY	84%**	84.7%
Reference:	Tr. 556	PX 1235
MELT INDEX	1.0*	6.3%
Reference:	PX 426	PX 1235
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	0.16
Percent Comonomer (Du Pont):	1.0%**	0.96%
Reference:	Tr. 556	PX 1235A
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	0.05% Butene
Reference:		DX 2704
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Film	Film
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Good	Good
Reference:	PX 426	PX 1233
CLAIMS INFRINGED	2, 5, 10,	2, 5, 10
Reference:	Tr. 557-58	Tr. 559-60
Other References:	Tr. 555-58	Tr. 559-60

PHILLIPS MARLEX PRODUCT	ER9-0032 (70% HMN 6060)	JX-676
COMONOMER	hexene-1	hexene-1
Reference:	PX 389, PX 272	PX 428
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.960**	.961*
Reference:	Tr. 560	PX 428
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	70% HMN 6060	.960-.963
Reference:		DX 2365C
PERCENT CRYSTALLINITY X-RAY	85.2%**	85%**
Reference:	Tr. 560	Tr. 562
MELT INDEX	See HMN 6060	6.5*
Reference:	PX 389	PX 428
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)	70% HMN 6060	
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	1.02%**	1.0%**
Reference:	Tr. 560	Tr. 562
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Injection Molding	Wire Coating
ENVIRONMENTAL STRESS CRACK RESISTANCE	—	—
IMPACT TOUGHNESS	Good	Good**
Reference:	PX 389, PX 272	PX 428, Tr. 534-35
CLAIMS INFRINGED	2, 5,	2, 5,
Reference:	Tr. 561	Tr. 562-63
Other References:	Tr. 560-61	Tr. 562-63

PHILLIPS MARLEX PRODUCT	M-339F (Fluff)	M-428
COMONOMER	hexene-1	hexene-1
Reference:	Levett 642	Levett 642-43
DENSITY—Sample Preparation by:	NO SAMPLE	NO SAMPLE
1) Du Pont 1955 Method	—	—
Reference:		
2) ASTM D1928 Proc. C (Du Pont)	.932-.935*	.944-.947*
Reference:	PX 430	PX 431
3) ASTM D1928 Proc. C (Phillips)	—	—
Reference:		
4) Phillips Product Specification	.932-.935	.944-.947
Reference:	PX 430	PX 431
PERCENT CRYSTALLINITY X-RAY	69%**	74%**
Reference:	Tr. 563	Tr. 564
MELT INDEX	0.70-0.90*	0.35-0.42*
Reference:	PX 430	PX 431
Fluff Melt Index	—	—
Reference:		
PERCENT COMONOMER (BY WEIGHT)		
1) Methyl Groups Per 100 Carbons:	—	—
Percent Comonomer (Du Pont):	4.0%**	2.0%**
Reference:	Tr. 563	Tr. 564
2) Corrected Methyl Groups Per 100 Carbons (Phillips):	—	—
Corrected Percent Comonomer:	—	—
Reference:		
3) Harwood NMR Data:	—	—
Reference:		
4) Phillips (Hsieh) NMR Data:	—	—
Reference:		
END USE	Base Resin Levett 460	Pipe & Coating Levett 642-43
ENVIRONMENTAL STRESS CRACK RESISTANCE	Meets Western Electric MS 59062 and REA 200, App. C**	Exceptional**
IMPACT TOUGHNESS	—	—
Reference:	Tr. 535-37	Tr. 537
CLAIMS INFRINGED	2, 5, 14	2, 5, 14
Reference:	Tr. 563	Tr. 564-65
Other References:	Tr. 563	Tr. 563-65

APPENDIX II

ADDITIONAL EXHIBIT REFERENCES AND LEVETT DEPOSITION TRANSCRIPT REFERENCES ON INFRINGING PHILLIPS PRODUCTS

(D.I. 240 through 245)

Phillips Product	Trial Exhibits	Levett Deposition Transcript References
HHM 4515	PX 152, PX 317	pp. 25 to 26, pp. 28 to 37, pp. 40 to 41, pp. 459 to 460
HHM 4520	PX 154, PX 155, PX 158, PX 161 PX 243	pp. 43 to 49, pp. 53 to 62, pp. 79 to 86, pp. 98 to 99
HMN 4550 (or BX-470)	PX 162 to 165, PX 275	pp. 100 to 111, pp. 394 to 397
HHM 4903	PX 153, PX 166, PX 168 to PX 172, PX 212, PX 247	pp. 111 to 113, pp. 128 to 129, pp. 132 to 133, pp. 214 to 221
HHM 4903-01	PX 166	
HMN 5060 (or BX-573)	PX 183 to PX 186 PX 275, PX 318	pp. 172 to 177, p. 184, pp. 460 to 461
HHM 5202	PX 153, PX 187 to PX 192, PX 247, PX 1297	pp. 178 to 185
HHM 5202-01	PX 187	pp. 178 to 179
HHM 5202-02-LD		
HHM 5502	PX 153, PX 192 to PX 198, PX 247, PX 378, PX 1228 PX 1298	pp. 183 to 192, p. 547
HHM 5502-LD	PX 192, PX 199	pp. 183, pp. 192 to 195
HHM 5502-01	PX 192 to PX 195	pp. 183 to 185, pp. 188 to 189

Phillips Product	Trial Exhibits	Levett Deposition Transcript References
HHM 5502-02-LD		
HHM 5502-03	PX 193 to PX 195	pp. 188 to 189
HMN 54140 (or BX-574)	PX 200 to PX 203, PX 275	pp. 196 to 200
HMN 5550	PX 204 to PX 206	pp. 200 to 204
HMN 5580 (or BX-572)	PX 207 to PX 210, PX 275	pp. 204 to 211
HHN 5710 (or BX-571)	PX 266 to PX 269, PX 319	pp. 378 to 380, p. 461
HMN 6060 (or BX-672)	PX 270 to PX 275, PX 1351	pp. 383 to 392
HHM TR-100 (7.5% Elastomer)	PX 211, PX 213, PX 214	pp. 212 to 214, pp. 221 to 238
HHM TR-102 (30% Elastomer)	PX 263 to PX 265	pp. 373 to 377
HHM TR-130 (or D-320)	PX 246, PX 277 to PX 281, PX 320, PX 377, PX 379	pp. 327 to 329, pp. 401 to 407, p. 462, pp. 546 to 549
HHM TR-140 (or D-420)	PX 246, PX 282 to PX 285, PX 379	pp. 407 to 414, pp. 548 to 549
HHM TR-144 (or D-422)	PX 286, PX 287, PX 379	pp. 415 to 416, pp. 548 to 549
HHM TR-150 (or D-506)	PX 259 to PX 262	pp. 364 to 367, pp. 369 to 373
HHM TR-210 (or J-440)	PX 244, PX 288 to PX 295	pp. 417 to 424
HHM TR-226 (or J-426)	PX 244, PX 296, PX 298, PX 299	pp. 322 to 325, pp. 425 to 427, pp. 427 to 430
HHM TR-230 Black (or J-320 or J-339)	PX 244, PX 343, PX 346, PX 349 to PX 351	pp. 322 to 325, pp. 496 to 499, pp. 502 to 503, pp. 507 to 509, p. 514
HHM TR-232 Black (or J-322)	PX 353 to PX 355	pp. 322 to 325, pp. 511 to 514

Phillips Product	Trial Exhibits	Levett Deposition Transcript References
HHM TR-232 Yellow (or J-325)	PX 356, PX 358	pp. 514 to 517, p. 519
HHM TR-236 Black	PX 303 to PX 305	pp. 434 to 438
HHM TR-250 Black (or J-510)	PX 395, PX 306 to PX 308	pp. 322 to 325, pp. 438 to 441
HHM TR-257 (or J-517)	PX 309, PX 310	pp. 441 to 443
HHM TR-400 (or H-310)	PX 245, PX 311 to PX 313	pp. 444 to 448
HHM TR-401 (or H-460)	PX 245, PX 314 to PX 316	pp. 448 to 453
HHM TR-415 Black	PX 323, PX 1232	pp. 464 to 465
HHM TR-416 Black	PX 244, PX 326, PX 329 to PX 331	pp. 470 to 477
HHM TR-418 Black	PX 218, PX 224 to PX 229, PX 245	pp. 243 to 246, pp. 263 to 274
HHM TR-418 Orange 728 Fluff 728-01	PX 231, PX 233 to PX 236, PX 245, PX 383	pp. 277 to 281, pp. 284 to 291, pp. 566 to 567
HHM TR-418 White	PX 237	pp. 287 to 291
HHM TR-418 Yellow	PX 238	p. 292
HHM TR-418-01 Orange		
HHM TR-460	PX 333, PX 336, PX 337	pp. 483 to 485, p. 489
HHM TR-480 Black	PX 245, PX 338 to PX 342	pp. 490 to 496
HMN TR-938 (or LX-471)	PX 239 to PX 241, PX 275, PX 321, PX 322	p. 293, pp. 296 to 301, pp. 463 to 464
HMN TR-942 JV		

Phillips Product	Trial Exhibits	Levett Deposition Transcript References
HMN TR-942 (or LX-470)	PX 275, PX 359 to PX 364	pp. 521 to 527
HMN TR-950 (or LX-571)	PX 242, PX 366 to PX 369	pp. 318 to 319, pp. 530 to 533
HMN TR-954 (or LX-570)	PX 242, PX 370 to PX 373	pp. 318 to 319, pp. 533 to 537
DTR	PX 374	pp. 537 to 540
DTR-01	PX 374	p. 540
D-510	PX 215 to PX 217	pp. 238 to 242
H-328	PX 230, PX 232	pp. 274 to 277, pp. 282 to 283
J-425	PX 297, PX 300 PX 301	p. 428, p. 432
BX-575	PX 394 to PX 396	pp. 583 to 587
BX-579	PX 397, PX 398	pp. 587 to 590
BX-671JX (or BX-671)	PX 275, PX 399 to PX 401	pp. 394 to 397, pp. 590 to 594
BX-673	PX 402 to PX 405	pp. 394 to 397, pp. 595 to 598
C-551	PX 406, PX 407	pp. 559 to 604
C-552-LD	PX 381, PX 382	pp. 554 to 557
C-555	PX 409 to PX 411	pp. 608 to 612
D-310 (or M-320)	PX 412 to PX 414, PX 416 to PX 417	pp. 612 to 616, pp. 619 to 622
D-321	PX 419 to PX 421	pp. 622 to 629
D-442	PX 422, PX 423	pp. 629 to 631
D-521	PX 424, PX 426 PX 427	pp. 631 to 632, pp. 634 to 635
DX-611	PX 1233, PX 1349, PX 1350	
ER9-0032 (70% HMN 6060)	PX 389	pp. 577 to 578
JX-676	PX 428, PX 429	pp. 636 to 639
M-339F (Fluff)	PX 430	pp. 640 to 642
M-428	PX 431	pp. 642 to 645

Judgment of the District Court, February 26, 1987

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

CIVIL ACTION NO. 81-508-JLL

E.I. DU PONT DE NEMOURS & COMPANY,

Plaintiff,

v.

PHILLIPS PETROLEUM COMPANY,
PHILLIPS 66 COMPANY,
AND PHILLIPS DRISCOPIPE, INC.,

Defendants.

JUDGMENT

For the reasons set forth in this Court's Findings of Fact and Conclusions of Law embodied in the Opinion entered in this case on this date, it is

ORDERED, ADJUDGED AND DECREED that:

1. The defendants' pretrial motion for summary judgment to dismiss this action under the doctrine of collateral estoppel based on the rejection of all claims of plaintiff's U.S. Patent No. 4,076,698 ("the '698 patent") by a patent examiner in a reissue/reexamination proceeding in the Patent Office is hereby denied.

2. The defendants have not met their burden of proving by clear and convincing evidence that plaintiff's '698 patent is invalid (a) based on its anticipation references under 35 U.S.C. § 102, or (b) based on obviousness under 35 U.S.C. § 103, or (c) based on claim indefiniteness under 35 U.S.C. § 112 (second paragraph).

3. The defendants have not met their burden of proving by clear and convincing evidence that the '698 patent is unenforceable for any of the reasons advanced by defendants.

4. The plaintiff has met its burden of proving by a preponderance of the evidence that the 73 accused ethylene-hexene-1 copolymers (referred to in Appendix I to the Opinion) and 9 Driscopipe products (listed in the Opinion) are within the scope of the asserted claims of the '698 patent and that defendants have infringed claims 1, 2, 5, 10, 12, and 14 thereof.

5. Plaintiff has not met its burden of proving by clear and convincing evidence that defendants' infringement was wilful so as to increase any award for damages under 35 U.S.C. § 284.

6. The defendants, their officers, agents, employees, and licensees, if any, are hereby permanently enjoined from continuing to infringe, manufacture, use, or sell any product which embodies the invention of the plaintiff's '698 patent.

7. An accounting to determine damages for defendants' past infringement is hereby ordered.

/s/ JAMES L. LATCHUM

United States District Judge

Dated: February 26, 1987.

Judgment of the Court of Appeals, June 15, 1988

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

87-1259 and 87-1284

E.I. DUPONT DE NEMOURS & COMPANY,

Plaintiff-Appellant,

v.

PHILLIPS PETROLEUM COMPANY,
PHILLIPS 66 COMPANY,
AND PHILLIPS DRISCOPIPE, INC.,

Defendants-Cross-Appellants.

JUDGMENT

On Appeal from the United States District Court for the District of Delaware

in Case No(s). 81-508

This CAUSE having been heard and considered, it is

ORDERED and ADJUDGED:

AFFIRMED IN PART, REVERSED IN PART, VACATED IN PART AND REMANDED

ENTERED BY ORDER OF THE COURT

/s/ FRANCIS X. GINDHART

Francis X. Gindhart, Clerk

Dated: June 15, 1988
Issued as a Mandate: July 28, 1988
Costs: Against Appellant

Order of the Court of Appeals Denying Petition for Rehearing, July 14, 1988

Note: This Order has not been prepared for publication in a printed volume because it does not add significantly to the body of law and is not of widespread legal interest. It is a public record. It is not citable as precedent.

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

87-1259 and 87-1284

E. I. DUPONT DE NEMOURS & COMPANY,

Plaintiff-Appellant,

v.

PHILLIPS PETROLEUM COMPANY,
PHILLIPS 66 COMPANY,
AND PHILLIPS DRISCOPIPE, INC.,

Defendants-Cross-Appellants.

Before BISSELL *Circuit Judge,* and MILLER, *Senior Circuit Judge.*

ORDER

A petition for rehearing having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for rehearing be, and the same hereby is, denied.

The suggestion for rehearing in banc is under consideration.

FOR THE COURT:

/s/ FRANCIS X. GINDHART
Francis X. Gindhart, Clerk

Date: July 14, 1988
cc: Mr. John O. Tramontine
Mr. Harry J. Roper
Mr. Ford F. Farabow